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Technologies and Management Strategies for Hazardous Waste Control

Volume II—Working Papers

Part A

Hazardous Waste Categories: A Review of Literature and Past Research Effort

April 1983

CONGRESS OF THE UNITED STATES
Office of Technology Assessment
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Preface

This volume contains papers written for OTA to assist in preparation of the report *Technologies and Management Strategies for Hazardous Waste Control.* OTA does not endorse these papers. In several instances, the OTA report reaches somewhat different conclusions because of additional information which was obtained later. These papers, however, may prove valuable for readers needing more detailed or specific information than could be accommodated in the final assessment report, and are being made available for such purposes.

HAZARDOUS WASTE CATEGORIES:
A REVIEW OF LITERATURE AND PAST RESEARCH EFFORT

VOLUME I - REPORT

Prepared for

Office of Technology Assessment
U.S. Congress

Prepared by

Sterling Hobe Corporation
1747 Pennsylvania Ave., N.W.
Washington, D.C. 20006

September 1980

FOREWORD

The principal author of this report was Ivars Gutmanis of Sterling Hobe Corporation. This study could not have been completed without the kind cooperation of the various government officials, representatives of international organizations, scholars in academia and industry executives. We are grateful for their significant assistance in completing this study. Appendix A contains their names and affiliations.

TABLE OF CONTENTS

Page

Foreword

Executive Summary ES-1

List of Figures vi

List of Tables vii

List of Acronyms viii

Introduction 1

CHAPTER ONE. HAZARDOUS WASTE CATEGORIZATION BY THE ENVIRONMENTAL PROTECTION AGENCY 6

1.1 Introduction 6

1.2 Resource Conservation and Recovery Act Authority and Legislative History 7

1.3 Consideration of Degree of Hazard in the Proposed RCRA Regulations

  1.3.1 Criteria for Listing Wastes as Hazardous 17

1.4 Comments on the Proposed RCRA Regulations 24

  1.4.1 Response to Comments and Rationale for the Federal Regulations 28

  1.4.2 Feasibility of Establishing a Degree of Hazard System 30

  1.4.3 Accomplishment of Major Objectives of Degree of Hazard System 33

1.5 Degree of Hazard Schemes Proposed By Various Interested Parties

CHAPTER TWO. HAZARDOUS WASTE CATEGORIZATION BY STATES

2.1 Introduction 62

2.2 California Degree of Hazard System 63

TABLE OF CONTENTS
(continued)

Page

2.2.1 California Procedures for Evaluating the Hazardous and Extremely Hazardous Properties of Wastes 68

2.3 Texas Degree of Hazard System 78

2.3.1 Texas Hazard Index 82

2.4 Washington Degree of Hazard System 83

2.5 Rhode Island Degree of Hazard System 87

2.5.1 Toxic Wastes 87

2.5.2 Reactive Wastes 90

2.5.3 Flammable Wastes 91

2.5.4 Corrosive Wastes 92

2.5.5 Infectious Wastes 93

2.5.6 Radioactive Wastes 93

2.5.7 Irritating Wastes 93

2.5.8 Sensitizers 94

2.5.9 Other Hazardous Wastes 94

2.6 Examples From Other States 95

2.6.1 Maryland Degree of Hazard System 95

2.6.2 Nebraska 98

2.6.3 Kentucky 99

CHAPTER THREE. HAZARDOUS WASTE CATEGORIZATION BY VARIOUS NON-GOVERNMENT ORGANIZATIONS IN THE UNITED STATES

3.1 TRW Systems Group Recommended Methods of Reduction, Neutralization, Recovery or Disposal of Hazardous Waste 100

TABLE OF CONTENTS
(continued)

Page

3.2 National Academy of Science Systems for Evaluation of the Hazards of Bulk Water Transportation of Industrial Chemicals 105

3.3 Battelle Memorial Institute Program For The Management of Hazardous Wastes 108

3.4 Booz-Allen Applied Research, Inc. A Study of Hazardous Waste Materials, Hazardous Effects and Disposal Methods 111

CHAPTER FOUR. HAZARDOUS WASTE CATEGORIZATION BY INTERNATIONAL ORGANIZATIONS 115

CHAPTER FIVE. HAZARDOUS WASTE CATEGORIZATION BY INTERNATIONAL NON-GOVERNMENT ORGANIZATIONS

CHAPTER SIX. HAZARDOUS WASTE CATEGORIZATION SCHEMES IN SITU OF DEPOSITORY

6.1 Rating the Hazard Potential of Waste Disposal Sites 118

    6.1.1 Generic Areas 118

    6.1.2 Rating Factors 119

    6.1.3 Receptors 121

    6.1.4 Pathways 122

    6.1.5 Waste-Characteristics 124

    6.1.6 Sax's Toxicity Ratings 125

    6.1.7 N.F.P,A.'s Toxicity Ratings 128

    6.1.8 Waste Management Facilities 131

    6.1.9 Rating Scales 133

    6.1.10 Multipliers 133

    6.1.11 Additional Points 135

CHAPTER SEVEN. RISK ANALYSIS OF HAZARDOUS WASTES 138

TABLE OF CONTENTS
(continued)

Page

CHAPTER EIGHT. CRITICAL REVIEW OF WASTE CATEGORIZATION SCHEMES BY DEGREE OF HAZARD

8.1 Salient Issues of Degree of Hazard Schemes 140

8.2 Critical Comparisons of Hazard Categorization Schemes 145

  8.2.1 Chemical Manufacturers Association (CMA) Scheme 146

  8.2.2 Proposed Scheme #2 148

  8.2.3 Proposed Scheme #3 149

  8.2.4 Proposed Scheme #4 149

  8.2.5 Proposed Scheme #5 150

  8.2.6 Proposed Scheme #6 150

  8.2.7 Proposed Scheme #7 151

  8.2.8 Proposed Scheme #8 151

  8.2.9 Proposed Scheme #9 151

  8.2.10 Proposed Scheme #10 152

  8.2.11 Proposed Scheme #11 153

  8.2.12 Proposed Scheme #12 153

  8.2.13 State of California Scheme 154

  8.2.14 State of Texas Scheme 155

  8.2.16 State of Washington Scheme 156

  8.2.17 State of Rhode Island Scheme 156

8.3 Conclusions 157

TABLE OF CONTENTS
(continued)

VOLUME II - APPENDICES Page

APPENDIX A - INDIVIDUALS INTERVIEWED DURING THE COURSE OF THIS STUDY A-1

APPENDIX B - HAZARDOUS WASTE CATEGORIZATION BY INTERNATIONAL ORGANIZATIONS B-1

APPENDIX C - HAZARDOUS WASTE CATEGORIZATION BY INTERNATIONAL NON-GOVERNMENT ORGANIZATIONS C-1

LIST OF FIGURES

Figure		Page
1	Waste Generation and Control Level	159
2	Classification of Solid Wastes By Toxicity	160
3	Illustrative Characteristics To be Taken Into Account In A Hazardous Waste Treatment/Disposal Classification System	161
4	Illustrative Hazard Values and Other Properties For Various Waste Characteristics	162
5	Treatment/Disposal Facility Description And Symbol Designation	164
6	Illustrative Minimum Reportable Quantities For Different Hazard Values	165
7	Illustrative Format For Listing Hazardous Waste Characteristics	166
8	Waste Classification And Treatment/Disposal Decision Tree - Part I	167
9	Waste Classification And Treatment/Disposal Decision Tree - Part II	168
10	Illustrative Hazardous Waste Classification And Treatment/Disposal Form	169
11	Graphic Representation Of The Hazardous Waste Decision Model	

LIST OF TABLES

Table Page

1 Estimated Research Expenditures on Hazardous Wastes By The Office of Research and Development (ORD), EPA 173

2 Nonradioactive High-Hazard Compounds 174

3 Hazardous Waste From Nonspecific Sources 177

4 Hazardous Waste From Specific Sources 179

5 Discarded Commercial Chemical Products, Off-Specification Species, Containers, and Spill Residues Thereof, Classified as Hazardous Waste, By The Environmental Protection Agency 185

6 Commercial Chemical Products Or Manufacturing Chemical Intermediates Identified As Toxic Wastes By The Environmental Protection Agency 195

7 Maximum Concentration of Contaminants for Characteristic of EP Toxicity 204

8 Exempt Quantities for Hazard Classification 205

9 Mammalian And Aquatic Toxicity Ranges 206

10 Exempt Concentrations for Hazard Classification 207

11 State Regulation of Hazardous Waste 208

12 Hazardous Waste Classification Characteristics, Department of Environmental Control, State of Nebraska 210

13 Criteria For The Identification of Candidates For National Disposal Sites 211

14 Summary of Hazard Evaluation Criteria 212

15 Persistence (Biodegradability) Of Some Organic Compounds 213

16 Guidance For Assessing The Presence Of Incompatible Wastes 219

17 Rating Factors And Scales For Each Of The Four Generic Areas 222

18 Commonly Used Characteristics To Classify Hazardous Wastes 224

19 Summary Degree Of Hazard Categorization Schemes 225

LIST OF ACRONYMS

AEP	Acid extraction procedure
CMA	Chemical Manufacturers Association
CONCAWE	Conservation of Clean Air and Water in Europe (Oil Companies Study Group)
CPSC	Consumer Products Safety Commission
ECDIN	Environmental Chemicals Data and Information Network
EEC	European Economic Community
EP	Extraction procedure
EPA	Environmental Protection Agency
HI	Hazard Index
IAES	International Academy for Environmental Safety
IARC	International Agency for Research on Cancer
ILm	Mean inhibitory limit
IMCO	Intergovernmental Maritime Consultive Organization (UN)
MPC	Maximum permissible concentration
NAS	National Academy of Sciences
NATO	North Atlantic Treaty Organization
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NIPDWS	National Interim Primary Drinking Water Standard
NTIS	National Technical Information System
OECD	Organization for Economic Cooperation and Development
ORD	Office of Research and Development
OSW	Office of Solid Waste
RCRA	Resource Conservation and Recovery Act
SCOPE	Scientific Committee on Problems of the Environment

LIST OF ACRONYMS
(continued)

TLm	Median threshold limit
TLV	Threshold Limit Values
TSCA	Toxic Substances Control Act
UN	United Nations
UNEP	United Nations Environment Programs
UNIDO	United Nations Industrial Development Organization
VHI	Vapor hazard index
WAC	Washington Administrative Code
WEP	Water Extraction Procedure

EXECUTIVE SUMMARY

The development of waste categorization schemes by degree of hazard is still in its infancy, although recognition that such schemes are important for proper and cost-effective hazardous waste management is increasing rapidly. The irony of the importance of degree of hazard schemes side by side with this lack of development is well exemplified by the efforts of various international organizations (See Appendix B). Almost all international organizations concerned with environment, public health and public policy have recognized the need to develop and implement comprehensive waste categorization schemes by degree of hazard.

This recognition has resulted in a selectively significant effort to collect pertinent data on the hazards of various wastes to public health and welfare. Additional efforts have included the classification of collected information with respect to specific hazards, and appropriate design and implementation of storage and retrieval systems of this information. While almost all international organizations recognize the need to develop waste categorization schemes by degree of hazard and have so stated publicly, the reality of achievement has been postponed to some future date.

One of the principal reasons for this delay is the need for such organizations to establish a fundamental set of agreements among various nations, always a long and tedious task in the international arena. However, even if the handicap of the need to reach agreements across various national boundaries is removed, very little has been accomplished with regard to the design, development and implementation of such schemes.

For example, in the case of non-government international organizations which clearly need not concern themselves with political and related factors, no waste categorization schemes by degree of hazard have been developed. However, such organizations have explicitly and repeatedly stated the need for such schemes. The same situation is essentially true for individual nations. As noted in Appendix B, all industrialized nations have established a definition and classification system which identifies hazardous wastes. Further, some of these countries have selected those wastes which are more hazardous than others, thus creating two hazardous waste categories.

The methodology used to establish this two-tier classification system is identical in all cases; the more hazardous wastes have been simply listed as such, and these listings have either been incorporated into hazardous waste management regulations, with special management provisions, or more hazardous waste listings have been published for public information without providing special management regulations.

In summary, there is very little to be obtained from international organizations, non-government international organizations or foreign countries with respect to categorizations of hazardous waste by degree of hazard.

The efforts in the U.S. to develop such schemes represent only limited improvement over other nations. The early attempts by the Environmental Protection Agency (EPA) beginning in 1974 to distinguish more hazardous wastes among all hazardous wastes consisted simply of preparing a listing of such wastes; this listing included existing regulations regarding how such wastes should be managed. In a similar manner, the EPA, as well as other Federal Government units, have prepared and expanded listings of wastes and chemical substances with carcinogenic characteristics. Further, other Federal Government units have occassionally prepared and updated listings as well as management regulations for special kinds of wastes such as those originating in hospitals, wastes with radioactive properties and others. However, the prescribed manner for disposal of hazardous wastes by the enactment of the Resource Conservation and Recovery Act (RCRA) and the annotated waste management regulations prescribed by the EPA required stringent and costly hazardous waste disposal practices. Numerous industries and firms, faced with additional operating costs caused by expenditures made for waste disposal, proposed a number of schemes, but this activity was limited.

Waste Categorization Schemes by Degree of Hazard and RCRA

RCRA has had a significant impact on waste categorization schemes by degree of hazard for several important reasons.

First, Congressional hearings on RCRA focused attention on hazardous wastes, the degree of such wastes, and of waste categories by degree of hazard. Because the less hazardous wastes presumably could be disposed of in a less costly manner, these schemes were forwarded to the EPA for consideration.

A number of States, because of the RCRA legislation and related reasons, had designed and implemented their own hazardous waste categorization schemes by degree of hazard. These schemes were also submitted to EPA as probable candidates.

The EPA, after considerable deliberation, concluded that it could not develop a satisfactory waste categorization by degree of hazard and further determined that none of the proposed schemes by various industry groups and general public were satisfactory. Finally, the EPA concluded that none of the State schemes could be used for nationwide degree of hazard classification schemes.

In place of degree of hazard classification, EPA prepared a comprehensive listing of over 700 wastes/chemicals that were considered hazardous. This universe of hazardous wastes is comprised of the following components:

1. Hazardous Wastes - Generic
    - Hazardous waste from nonspecific sources
    - Hazardous waste from specific sources
2. Discarded commercial chemical products, off-specification species, container and spill residues thereof;
3. Commercial chemical products or manufacturing chemical intermediates.

For practical purposes, this means that the EPA elected not to categorize hazardous wastes by degree of hazard. Rather, they chose to list hazardous wastes originating from the sources listed above.

The EPA classified the wastes as hazardous on the basis of the following four characteristics: ignitability, corrosivity, reactivity, and EP toxicity.

One of the principal reasons for EPA's inability to design an appropriate degree of hazard scheme appears to be that clear boundaries among the various degree of hazard categories could not be established. These difficulties were compounded by EPA's establishment of two types of hazards: the intrinsic hazard of waste; and hazard of exposure of the waste to the public in waste treatment facilities. EPA then attempted to link these two hazards to a degree of hazard classification scheme.

The EPA further argued that because the exposure hazard depends on the salient characteristic of the dispos~~ed~~al site, such as soil type, local hydrology, or proximity of the site to population, it could not establish the waste hazard degree categorization scheme on a nationwide basis.

Finally, the EPA argued that any such scheme would require prohibitively expensive laboratory analyses, some of which are not well established.

The EPA's approach to deal with waste categories with different degrees of hazards came in the form of differentiating the categories in terms of waste management regulations which are to be developed in the future.

Industry groups and others believing that such schemes can be developed, related to EPA their proposed degree of hazard categorization schemes, and have maintained that the EPA's refusal to develop such schemes was not warranted by available information.

The following section presents a summary description and critique of those schemes which are comprehensive and appear to meet most of the objections for a nationwide scheme of hazardous waste categorization by degree of hazard.

REVIEW OF HAZARDOUS WASTE CATEGORIZATION SCHEMES BY DEGREE OF HAZARD

Two separate sources comprise the schemes of hazardous waste categorization by degree of hazard. The first is represented by the various industry groups and others who, in response to RCRA, presented proposals of hazardous waste categorization schemes by degree of hazard to EPA. Not all proposed schemes were considered adequate - some of the proposals were vague, or too general, and therefore could not be seriously considered. However, three schemes are sufficiently detailed and comprehensive to merit detailed analysis.[1]

Table ES-1, found at the end of the Executive Summary, presents the main features of those schemes.

PROPOSED CLASSIFICATION SCHEMES by Chemical Manufacturers Association (CMA)

This scheme proposes five divisions for degree of hazard categories based on Section 3001 hazard characteristics (i.e., ignitability, corrosivity, reactivity, toxicity), and on other test results. The five divisions are:

---

[1] These three schemes have been classified in this report as 1) Scheme by the Chemical Manufacturers Association (CMS); 2) Proposed Scheme #4; and 3) Proposed Scheme #5. The remaining nine schemes proposed to the EPA and discussed in this report were considered unsatisfactory for nationwide degree of hazard scheme.

Class I - High Hazard

These wastes, if improperly handled, could present a high hazard to health or the environment, and therefore require special care in storage, handling and disposal. Included in this class would be persistent, mutagenic, and high-to-moderate acutely toxic wastes, plus wastes that would present a high hazard to drinking water supplies.

Class II - Moderate Hazard

This class includes wastes that could present a moderate degree of hazard to health or the environment if improperly handled, but which can be safely handled and disposed in a well designed and operated hazardous waste management facility. Moderate or low toxicity wastes with unusually high accumulation potentials or persistence characteristics would be included. Ignitable wastes, reactive wastes, and wastes posing moderate potential danger to drinking water sources would also fit into this class.

Class III - Low Hazard

This class would include those wastes which, although categorized as "hazardous", nonetheless represent only a minimal potential hazard to health or the environment. Included would be wastes of low toxicity, and nonaccumulative, non-persistent moderate toxicity wastes, as well as corrosive wastes and wastes of low potential hazard to drinking water.

Class IV - Special Wastes

These wastes were defined by EPA as special wastes in the proposed regulations, i.e., wastes generated in large volumes but which have low hazard or unique properties.

Class V - Radioactive and Infectious Wastes

These wastes would be designated in "special" categories, not in the sense of being high volume or low hazard, but rather as requiring special consideration for proper disposal.

As noted, CMA proposed high, moderate and low hazard categories and two additional categories, i.e., special wastes (wastes generated in very large volumes with low hazard) and radioactive infectious wastes.

The limits proposed by CMA for the three principal hazard categories while reasonable according to the EPA "...have no obvious justification." According to the EPA, a review of the other categorization schemes "... reveals numerous other, quite different, toxicity rankings."

The cardinal shortcoming of the CMA proposed scheme according to the EPA is that the proposed hazard ranking did not consider potential human health and environmental impacts in the event of past hazardous waste management practices. However, the EPA admitted that the linkage between hazard categories and potential mismanagement of hazardous wast is difficult if not impossible to establish. In this regard, "...the Agency knows of no way to appropriately make these links in a comprehensive degree of hazard ratings." Further, the EPA believes that while the intrinsic hazard of waste and exposure have been considered in its hazard ratings, CMA has failed to consider "...numerous site specific factors which cannot be adequately considered in a national hazard ranking;..." and that..."the site specific conditions have a more significant impact on exposure and risk than the...CMA's...suggested hazard ranking."

Clearly, if the EPA's views are carried to their logical conclusion, no degree of hazard categorization schemes are possible because the exposure component of the hazard will always depend on the uniquely specific characteristics of the dispos~~ed~~al site such as hydroecology, cover design, depth of groundwater, ~~and~~ soil type,

Proposed Classification Scheme #4

This scheme proposed at least three separate classifications of hazardous wastes.

Class I - This class would consist of those wastes which are life threatening because virtually any human exposure to such wastes is considered unacceptable.

Class II - This class would consist of those wastes which pose a serious hazard to human health and the environment during some phase of their storage, handling, treatment or disposal, but do not present the grave, constant and continuing hazard posed by Class I wastes.

Class III - This section consists of those wastes considered to be hazardous to human health or the environment only if the wastes are not handled in a prescribed, controlled manner.

The classification scheme #4, as noted, categorizes degree of hazard into three major categories on the basis of toxicity, reactivity and corrosivity levels. The classification is based in intrinsic hazard only and does not consider exposure in defining hazard levels.

This scheme is deficient in several other aspects. The justification and rationale are not clear for the ranking of hazardous characteristics into each of the hazard levels. The classification is not complete. For example, wastes with toxicity greater than $LD_{50} < 5$ mg/kg are not included. Moreover, carcinogenic and mutagenic wastes are not discussed. Important waste characteristics such as persistence and bioaccumulativity are not considered.

Management requirements of this scheme are very general and vague. Finally, this scheme does present quantity exclusion in a more comprehensive manner and to a greater extent than any other scheme. Unfortunately, no rigorous justification is presented for the suggested quantity exclusion limits.

Proposed Classification Scheme #5

This scheme suggested a two-tier degree of hazard system along the following lines: primary hazardous waste, special waste and reactive waste.

This scheme has the benefit of greater simplicity than many others because it has only two levels of hazard. It is relatively comprehensive in terms of characteristics and properties included in ranking. However, the scheme does not provide justification or rationale for characteristics included in the various hazard levels or for the limits within characteristics chosen to define those levels. There is is no suggestion of how management requirements would differ for the two tiers, or how the hazard ranking would otherwise be used. The scheme is based on intrinsic hazard only, and does not consider exposure in assigning hazard levels.

California Degree of Hazard System

The California State Department of Health has developed the following waste classification scheme: extremely hazardous waste: any hazardous waste or mixture of hazardous wastes which, if human exposure should occur, may likely result in death, disabling personal injury or serious illness caused by the hazardous waste or mixture of hazardous wastes because of its quantity, concentration, or chemical characteristics; and any waste or combination of wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may either:

cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

The criteria which have been developed by the California State Department of Health for defining a hazardous or extremely hazardous waste are categorized under toxicity; flammable; pressure-generating and reactive; corrosive; irritant; and strong sensitizer.

California is using this hazard degree categorization scheme relatively successfully. However, from the standpoint of a national regulation, the EPA notes the following shortcomings of the scheme: (1) EPA is not aware of the technical justification for the ranking of the hazard classes or the limits within a characteristic for placing wastes in different hazard classes; (2) all hazardous wastes defined by California, both hazardous and extremely hazardous, are taken to the same disposal facilities (Class I). The only difference in management requirements is in administrative and handling requirements. The EPA does not believe such limited differences justify a complicated National degree of hazard system; also, the definition of hazardous waste in California is different from that in the final EPA regulations. The hazardous wastes and substances used in listing hazardous wastes and structuring the degree of hazard system would not be applicable to EPA's hazardous waste definition without substantial modification.

Texas Degree of Hazard System

The definition of hazardous waste established by the Texas Department of Water Resources includes the following waste classification scheme which is based on the possible adverse impact that land disposal of certain types or classes of industrial solid waste might have:

Class I - any industrial solid waste or mixture of wastes, which because of its concentration or physical or chemical characteristics is toxic, corrosive, flammable, a strong sensitizer or irritant, generates sudden pressure by decomposition, heat, or other means and may pose a substantial present or potential danger to human health or the environment when improperly treated, stored, transported, disposed, or otherwise managed, including hazardous wastes identified by the administrator of the U.S. EPA pursuant to the Federal Solid Waste Disposal Act;

Class II - any industrial solid waste or combination of industrial solid wastes which cannot be described as Class I or Class III as defined in the regulation; and,

Class III - essentially inert and essentially insoluble industrial solid waste, usually including materials such as rock, brick, glass, dirt, certain plastics, rubber, etc., that are not readily decomposable.

In the Texas classification system, a list of hazardous substances and a set of criteria have been developed. The list of hazardous substances developed by Texas contains approximately 300 toxic substances, 100 corrosives or irritants, 250 flammable materials, 10 strong sensitizers and 40 pressure-generating materials. Seventy wastes are included on the list.

The criteria which have been developed by the Texas Department of Water Resources in defining a hazardous waste include:

	Class I	Class II	Class III
1. A calculated Hazard Index	≤ 50	> 50	> 50
2. A calculated or actually determined LD_{50} (by Finney's mathematical model for joint additive toxicity)	≤ 500 mg/kg	> 500 mg/kg	> 500 mg/kg
3. pH	< 2.5 and > 12	2.5 to 12	2.5 to 12
4. A corrosion rate on steel (SAE 1020) at a test temperature of 130°F as determined by NACE	> 0.25 in/yr	< 0.25 in/yr	< 0.25 in/yr
5. A flash point determined by a Pensky-Martens Closed Cup Tester, using ASTM Std. D-93-73	≤ 140°F	> 140°F	> 140°F

The Hazard Index (HI) of a material is a parameter developed by the Texas Department of Water Resources by which a material's possible environmental impact from improper disposal may be calculated based on the material's solubility and toxicity.

As noted, the State of Texas hazard degree categorization scheme contains three hazard categories determined by using Texas degree of hazard index. While this degree of hazard index is relatively comprehensive and well designed, it does not include some important waste characteristics such as carcinogenicity and is designed solely for land disposal.

The EPA notes two additional problems in applying the State of Texas scheme to national laws. "(1) Hazardous wastes, as defined by EPA, all appear to be in one class in Texas. The purpose of Texas degree of hazard system seems to be to distinguish between all hazardous wastes and two different classes of nonhazardous wastes. Thus, it does not appear to be applicable to determination of hazard levels among hazardous wastes; (2) In the Texas system, wastes are sent to the State for analysis and ranking. This is not feasible on a national level and is inconsistent with the approach to determination of hazard in the subtitle C regulations."

Washington Degree of Hazard System

The degree of hazard system for toxic wastes used by Washington State is based on a categorization scheme utilizing both aquatic toxicity (LC_{50}) and oral toxicity (LD_{50}). This basic scheme is as follows:

- Category A - any substance whichin its pure form has an oral $LD_{50} < 5$ mg/kg, or any substance which in its pure form has an aquatic $LC_{50} < 1$ ppm.
- Category B - any substance which in its pure form has an oral LD_{50} of between 5 to 50 mg/kg, or any substance which in its pure form has an aquatic LC_{50} between 1 and 10 ppm.
- Category C - any substance which in its pure form has an oral LD_{50} of between 50 to 500 mg/kg, or any substance which in its pure form has an aquatic LC_{50} of between 10 to 100 ppm.
- Category D - any substance which in its pure form has an oral LD_{50} of between 500 mg/kg to 5 g/kg, or any substance which in its pure form has an aquatic LC_{50} of between 100 to 1000 ppm.

(Substances with different oral LD_{50}'s and Lc_{50}'s will be classified in the more restrictive category.)

Based on this scheme, the Washington Department of Ecology has developed a two-tier degree of hazard system for toxic wastes which includes extremely hazardous wastes and dangerous wastes. The extremely hazardous category was to be distinguished from the dangerous category because of its persistence, bio-concentration of genetic effects, and extreme toxicity, or because such quantities present an extreme hazard to man or wildlife.

The specific criteria developed by the Department of Ecology include: dangerous wastes, which is considered hazardous due to toxicity to man and wildlife; hazardous due to quantity; and hazardous due to persistence and potential hazard. In addition to the above degree of hazard scheme for toxic wastes, the Department of Ecology has defined any waste greater than 50 kg (100 lb) in weight and which is corrosive, explosive, or flammable as physically dangerous wastes (i.e., no degree of hazard for these particular types of wastes).

Rhode Island Degree of Hazard System

The State of Rhode Island has developed a degree of hazard system along the following lines:

Toxic Wastes comprised of: Type 1A-Highly Toxic waste; type 1B-Moderately Toxic Waste; Type 1C-Slightly Toxic Waste;

Reactive Wastes comprised of: Type 2A-Highly Reactive Waste; Type 2B-Moderately Reactive Waste; and Type 2C-Slightly Reactive Waste;

Flammable Wastes comprised of: Type 3A-Highly Flammable Waste; Type 3B-Moderately Flammable Waste; and Type 3C-Slightly flammable Waste;

Corrosive Wastes comprised of: Type 4-Corrosive Waste;

Infectious Wastes comprised of: Type 5-Infectious waste;

Radioactive Wastes comprised of: Type 6-Radioactive Wastes;

Irritating Wastes comprised of: Type 7A-Highly Irritating Waste; Type 7B-Moderately Irritating Waste; Type 7C-Slightly Irritating Waste;

Sensitizers comprised of: Type 8-Strong Sensitizers; and

Other Hazardous Wastes comprised of: Type 9-Hazardous N.O.S. (Not Otherwise Specified).

The state of Rhode Island degree of hazard scheme is one of the most comprehensive and detailed systems designed. The major problem according to EPA is that no technical justification for the limits within characteristics and the ranking of characteristics used to define various degrees of hazard within a class are provided. Furthermore, relating management standards to this complex hierarchy is, in EPA's view, impractical. The EPA's comments on this scheme is as follows: "In requesting additional information from the State on this degree of hazard system, especially with respect to the technical justification for the various levels established, the commenter responded as follows:

> '....The standards established in these rules and regulations (Rhode Island) are arrived at by this Department with significant input from a 'Hazardous Waste Task Force' appointed by the Director of the Department and representing industrial, conservation, and government interests in our community. Therefore, these regulations represent, for the most part, agreed upon level of standards which are acceptable to many interests...The toxicity levels established for defining Types 1A, 1B and 1C were originally proposed by the industrial representation on our task force and were based, I understand, from findings by this industry that these levels were, for the most part, acceptable to other federal agencies such as the Consumer Product Safety Commission...'"

The commenter, however, failed to provide any actual technical justification as requested by EPA. This type of concensus rule-making with industry cannot be carried out at the Federal level.

Rating the Hazard Potential of Waste Disposal Sites

The EPA has attempted for half a decade to rate hazard potential of waste disposal sites.

The site-rating methodology has been developed in terms of six elements. These are:

- Generic areas
- Rating factors
- Rating scales
- Multipliers
- Additional points
- Hazard potential scores

In assessing the environmental impacts of any hazardous waste disposal site, four Generic Areas of consideration are addressed:

- Receptors
- Pathways
- Waste Characteristics
- Waste Management practices

Receptors refers to the biota (human and non-human) which are potentially affected by the materials released from a waste disposal site. Pathways refers to aspects of the routes by which hazardous materials can escape from a given site. Waste Characteristics refers to the types of hazards posed by materials in the facility in terms of both their health-related effects and their environmental mobility. Waste Management Practices refers to the design characteristics and management practices of a given disposal site as they relate to the site's environmental impact.

The prime importance of Generic Areas is in partitioning the Rating Factors into manageable groups so that site ratings can be more easily and completely interpreted.

The actual ratings of a waste disposal facility are based on a set of 31 Rating Factors. Each of these has been assigned to one of four generic areas. The Receptors generic area has five rating factors.

The Pathways generic area contains nine rating factors concerned with contaminant migration and attenuation potential. The primary focus is on waterborne pollutants, since they can affect the greatest number of people.

The Waste Characteristics generic area contains rating factors which examine the waste's environmental mobility and the adverse effects they can cause.

The Waste Management Practices generic area evaluates site design and operation. This generic area includes eight rating factors.

Many wastes, when mixed with others at a hazardous waste facility, can potentially produce adverse human health and environmental effects through means such as the following: (1) heat generation, (2) violent reaction, (3) release of toxic fumes and gases as a result of mixing, (4) release of toxic substances in case of fire or explosion, (5) fire or explosion, and (6) generation of flammable or toxic gases. The rating methodology also provides information of potentially incompatible waste materials or components and the adverse consequences resulting from mixing of waste in one group with waste in another group.

For each of the factors, a four-level rating scale has been developed which provides factor-specific levels ranging from "0" (indicating no potential hazard) to "3" (indicating a high potential hazard). The rating factors along with their corresponding rating scales for each of the generic areas are listed in Table ES-2*. These scales have been defined so that the rating factors can typically be evaluated on the basis of readily available information from published materials, public and private records, contacts with knowledgeable parties, or site visits. Raters compare the information collected for a site with the limits set in the scales and see which level of each scale most closely fits the information. The numeric value of that level is the site rating for that factor.

The rating factors do not all assess the same magnitude of potential environmental impact. Consequently, a numerical value has been assigned to each factor in accordance with the relative magnitude of impact that it does assess. These values are multiplied (hence the term multiplier) by the appropriate site ratings to result in site scores for each of the rating factors.

The result of a site rating is a set of five hazard potential scores. These scores are:

- Overall score
- Receptors subscore
- Pathways subscore
- Waste characteristics subscore
- Waste management practices subscore

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*Table ES-2 can be found at the end of this Executive Summary.

The overall score is based on all the rating factors and additional points that are used to rate a site. Each subscore is based on those rating factors and additional points in that generic area which are used to rate a site. All of these scores are normalized on a scale of 0 to 100. Associated with every hazard potential score is a percentage of missing and assumed data. These percentage flag scores are based on large amounts of missing data and, in a general way, measure the reliability of the scores.

TABLE ES-1
SALIENT FEATURES OF DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number Of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories
CMA	5	Class I - High Hazard	Ignitability Corrosivity Reactivity Toxicity (Section of 3001 EPA)	Class I - Extract fails mutagenic and persistence tests; or is an organic material of high acute toxicity; or is an organic material of moderate acute and fails persistence test; or contaminant at concentration greater than 1000 times the National Interim Primary Drinking Water Standard (NIPDWS)
		Class II - Moderate Hazard		Class II - Extract fails mutagenic test but does not fail resistence test; or is an organic material of moderate acute toxicity and either fails accumulation potential test, but does not fail persistence test or does not fail accumulation test, but fails persistence tests; or is an organic material of low acute toxicity that fails both accumulation potential and persistence test; or contains any contaminant at concentrations from 300 to 1000 times water standard, or fails ignitability characteristics.

Page 1 of 8

TABLE ES-1 (Continued)
SALIENT FEATURES OF DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number Of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories
		Class III - Low Hazard		Class III - Extract does not fail the accumulation potential test and does not fail a persistance test; or is an organic material of low acute toxicity and fails the accumulation test and passes a persistence test or passes the accumulation test; or contains any contaminant at concentrations from 100 to 300 times water standard; or fails the corrosive characteristic.
		Class IV - Special Wastes		Class IV - See EPA regulations on wastes generated in large volume with low hazard
		Class V - Radioactive and infectious		Class V - Radioactive and infectious wastes
Proposed Scheme #4	3	Class I - Waste which are life threatening	1) Toxicity 2) Reactivity 3) Certain listed wastes	In concentration greater than 100 ppm with oral mammalian LD_{50} of (5 mg/kg) or aquatic LC_{50} of (1.0 mg/l)
		Class II - wastes which pose a hazard during some phase of management	1) Ignitable wastes 2) Corrosive waste 3) Reactive waste 4) Toxicity	Flash point less than 37.8 C or is liable to ignite through friction etc., or is gas as defined in 49 CFR 173.300(b) or 49 CFR 173.51

Page 2 of 8

TABLE ES-1 (Continued)
SALIENT FEATURES OF DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number Of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories
				Ph less or equal to 2 or greater than or equal to 13, or corrodes steel at rate greater than 0.250 in. per year
				Extract yields concentration of substance which exceeds 100 times EPA National Interim Primary Drinking Water Standard
		Class III - wastes which are hazardous only if not handled in proper manner	1) Ignitable waste	Flash point less than 93° C.
			2) Corrosive waste	Ph less or equal to 3 or greater or equal to 12.
			3) Reactive waste	
			4) Toxicity	Extract yields concentration of substances which does not exceed 100 times Drinking Water Standards (NIPDWS)
Proposed Scheme #5	2	Primary Hazardous Waste	1) Toxicity 2) Reactive wastes	LD_{50} value equal or less than 100 mg/kg or LC value equal or less than 20 ppm. Waste characterized by significant persistence, bioaccumulation carcinogenicity mutagenicity or teratogenicity; §250.13(d) at 100 time the NIPDWS, §250.13(c) (1)(i), (1)(iii) and (1)(iv).
			3) Infectious wastes	Appendix VII 043 FR 58964

TABLE ES-1 (Continued)
SALIENT FEATURES OF DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number Of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories
		Special wastes	1) Toxicity	LD_{50} value between 100 mg/kg and 2500 mg/kg or LC_{50} value between 20 ppm and 500 ppm; §250.13(d) between 10 and 100 times NIPDWS.
			2) Ignitable wastes	§250.13(a)(1)(i) and (1)(ii) or flash point equal to or less than 100°F.
			3) Corrosive wastes	§250.13(b)(1)(i)
			4) Reactive wastes	§250.13(c)(1)(ii)
			5) Infectious wastes	Class B as classified by Joint Commission on Accrediting Hospitals or Class 2 as defined by CDC.
State of California	2	Extremely hazardous waste	1) Toxicity	Single oral $LD_{50} \leq 50$ mg/kg; dermal $LD_{50} \leq 200$ mg/kg; inhalation $LC_{50} \leq 200$ ppm
			2) Carcinogen	Listed in Cal-OSHA section 5209 Title I.
			3) Flammable	Flash point 37.8°C; mixture of 13% or less forms flammable mixture
			4) Reactive	CFR, Title 49, Sections 173.51; 173.53; 173.88 & 173.100 and is a water reactive material
			5) Corrosive	pH $\leq$ 2 or $\geq$ 12
			6) Irritant	
			7) Strong sensitizer	

TABLE ES-1 (Continued)
SALIENT FEATURES OF DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number Of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories
		Hazardous waste	1) Toxicity	Single oral $LD_{50} \leq 2000$ mg/kg; dermal $LD_{50} \leq 1200$ mg/kg; inhalation $LC_{50} \leq$ 4000 ppm.
			2) Carcinogen	Listed in Cal-OSHA Title 8
			3) Flammable	Flash point 37.8°C; mixture of 13% or less forms flammable mixture
			4) Reactive	CFR, Title 49 Section 173.51; 173.53; 173.88 & 173.100 & in water reactive material
			5) Corrosive	pH ≤ 2 or ≥ 12
			6) Irritant 7) Strong sensitizer	
State of Texas	3	Class I	1) Hazard Index	≤ 50 (see Text)
			2) LD_{50}	≤ 500 mg/kg
			3) pH	2.5 and 12
			4) Corrosion rate of steel	0.25 in./year (SAE 1020) at a test temperature 130°F
			5) Flash Point	≤ 140°F
		Class II	1) Hazard Index	> 50 (see Text)
			2) LD_{50}	> 500 mg/kg
			3) pH	2.5 to 12
			4) Corrosion rate of steel	$<$ 0.25 in./year

TABLE ES-1 (Continued)

SALIENT FEATURES OF DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number Of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories
			5) Flash Point	> 140°F
		Class III	1) Hazard Index	> 50 (see Text)
			2) LD_{50}	> 500 mg/kg
			3) pH	< 2.5 to 12
			4) Corrosion rate of steel	> 0.25 in./year
			5) Flash	140°F
State 5/ [illegible]	2	Dangerous Waste	1) LD_{50}	(see Text) < 5g/kg
			2) LC_{50}	(see Text) < 1000 ppm
			3) Etiologic agents	
		Extremely Hazardous Waste	1) LD_{50}	(see Text) 50 mg/kg
			2) LC_{50}	(see Text) > 10 ppm
			3) Quantity	Waste exceeds 50 kg (100 lbs) providing LD_{50} < 500 mg/kg and LC_{50} < 100 ppm (see Text)
			4) Persistence	Waste exceeds 50 kg and concentration of soluble heavy metals, halogenated HC or polycyclic, aromatic HC exceeds 1%
			5) Corrosive	pH > 11 and < 3 when mixed equal weight of water
			6) Explosive	WAC - Chapter 296-52
			7) Flammable	Flash point below 100°F.

Page 6 of 8

TABLE ES-1 (Continued)
SALIENT FEATURES OF DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number Of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories
State of Rhode Island	17	Type 1A-Highly Toxic Waste	1) LD_{50} or	0 to 50 mg/kg
			2) LC_{50} or	less than 0.1 ppm
			3) Quantative analysis of elutriate or	Concentration of any substance equal or greater than 10 times PDWS.
			4) octanol/water partition coefficient or	P greater than 3.0
			5) Carcinogen	Contains any chemical designated as a carcinogen
		Type 1B-Moderately Toxic Waste	1) LD_{50} or	$<$ 50 but $>$ 500 mg/kg
			2) LC_{50} or	$<$ 71 ppm but $>$ 0.4 ppm.
		Type 1C-Slightly Toxic Waste	1) LD_{50} or	$<$ 500 but $>$ 5,000 mg/kg
			2) LC_{50} or	$<$ 1 ppm but $>$ 10 ppm
		Type 2A-Highly Reactive Waste	1) Itself readily capable of initiating a detonation	
		Type 2B-Moderately Reactive Waste	2) Requires strong initiating source for detonation	
		Type 2C-Slightly Reactive Waste	1) Normally unstable, but does not detonate	

TABLE ES-1 (Continued)

SALIENT FEATURES OF DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number Of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories
		Type 3A-Highly Flammable Waste	1) Flash Point	Flash point between 73°F and boiling point less than 100°F
		Type 3B-Moderately Flammable Waste	1) Flash Point	As above (see Text)
		Type 3C-Slightly Flammable waste	1) Flash Point	Flash point above 100°F but below 200°F
		Type 4-Corrosive Waste	1) pH	< 3 and > 12
		Type 5-Infectious Waste	1) Presence of microorganisms	CDC classes 2 through 5
		Type 6-Radioactive Waste	(see Text)	
		Type 7-Highly Irritating Waste	1) Draize score	Score 6.6 to 8.0
		Type 7B-Moderately Irritating Waste	1) Draize score	Score 3.1 to 6.5
		Type 7C-Slightly Irritating Waste	1) Draize score	Score 1.6 to 3.0
		Type 8-Strong Sensitizers	Produces Allergic sensitization	
		Type 9-Hazardous N.O.S.	(see Text)	

Page 8 of 8

TABLE ES-2
RATING FACTORS AND SCALES FOR EACH OF THE FOUR GENERIC AREAS

RATING FACTORS	RATING SCALE LEVELS			
	0	1	2	3
RECEPTORS				
POPULATION WITHIN 1,000 FEET	0	1 TO 25	26 TO 100	GREATER THAN 100
DISTANCE TO NEAREST DRINKING-WATER WELL	GREATER THAN 3 MILES	1 TO 3 MILES	3,001 FEET TO 1 MILE	0 TO 3,000 FEET
DISTANCE TO NEAREST OFF-SITE BUILDING	GREATER THAN 2 MILES	1 TO 2 MILES	1,001 FEET TO 1 MILE	0 TO 1,000 FEET
LAND USE/ZONING	COMPLETELY REMOTE (ZONING NOT APPLICABLE)	AGRICULTURAL	COMMERCIAL OR INDUSTRIAL	RESIDENTIAL
CRITICAL ENVIRONMENTS	NOT A CRITICAL ENVIRONMENT	PRISTINE NATURAL AREAS	WETLANDS, FLOODPLAINS, AND PRESERVED AREAS	MAJOR HABITAT OF AN ENDANGERED OR THREATENED SPECIES
PATHWAYS				
EVIDENCE OF CONTAMINATION	NO CONTAMINATION	INDIRECT EVIDENCE	POSITIVE PROOF FROM DIRECT OBSERVATION	POSITIVE PROOF FROM LABORATORY ANALYSES
LEVEL OF CONTAMINATION	NO CONTAMINATION	LOW LEVELS, TRACE LEVELS, OR UNKNOWN LEVELS	MODERATE LEVELS OR LEVELS THAT CANNOT BE SENSED DURING A SITE VISIT BUT WHICH CAN BE CONFIRMED BY A LABORATORY ANALYSIS	HIGH LEVELS OR LEVELS THAT CAN BE SENSED EASILY BY INVESTIGATORS DURING A SITE VISIT
TYPE OF CONTAMINATION	NO CONTAMINATION	SOIL CONTAMINATION ONLY	BIOTA CONTAMINATION	AIR, WATER, OR FOODSTUFF CONTAMINATION
DISTANCE TO NEAREST SURFACE-WATER	GREATER THAN 5 MILES	1 TO 5 MILES	1,001 FEET TO 1 MILE	0 TO 1,000 FEET
DEPTH TO GROUNDWATER	GREATER THAN 100 FEET	51 TO 100 FEET	21 TO 50 FEET	0 TO 20 FEET
NET PRECIPITATION	LESS THAN -10 INCHES	-10 TO +5 INCHES	+5 TO +20 INCHES	GREATER THAN +20 INCHES
SOIL PERMEABILITY	GREATER THAN 50% CLAY	30% TO 50% CLAY	15% TO 30% CLAY	0 TO 15% CLAY
BEDROCK PERMEABILITY	IMPERMEABLE	RELATIVELY IMPERMEABLE	RELATIVELY PERMEABLE	VERY PERMEABLE
DEPTH TO BEDROCK	GREATER THAN 60 FEET	31 TO 60 FEET	11 TO 30 FEET	0 TO 10 FEET

Page 1 of 2

TABLE ES-2 (Continued)
RATING FACTORS AND SCALES FOR EACH OF THE FOUR GENERIC AREAS

RATING FACTORS	RATING SCALE LEVELS			
	0	1	2	3
WASTE CHARACTERISTICS				
TOXICITY	SAX'S LEVEL 0 OR NFPA'S LEVEL 0	SAX'S LEVEL 1 OR NFPA'S LEVEL 1	SAX'S LEVEL 2 OR NFPA'S LEVEL 2	SAX'S LEVEL 3 OR NFPA'S LEVELS 3 OR 4
RADIOACTIVITY	AT OR BELOW BACKGROUND LEVELS	1 TO 3 TIMES BACKGROUND LEVELS	3 TO 5 TIMES BACKGROUND LEVELS	OVER 5 TIMES BACKGROUND LEVELS
PERSISTENCE	EASILY BIODEGRADABLE COMPOUNDS	STRAIGHT CHAIN HYDROCARBONS	SUBSTITUTED AND OTHER RING COMPOUNDS	METALS, POLYCYCLIC COMPOUNDS, AND HALOGENATED HYDROCARBONS
IGNITABILITY	FLASH POINT GREATER THAN 200° OR NFPA'S LEVEL 0	FLASH POINT OF 140°F. to 200°F. OR NFPA'S LEVEL 1	FLASH POINT OF 80°F. TO 140°F. OR NFPA'S LEVEL 2	FLASH POINT LESS THAN 80°F. OR NFPA'S LEVELS 3 OR 4
REACTIVITY	NFPA'S LEVEL 0	NFPA'S LEVEL 1	NFPA'S LEVEL 2	NFPA'S LEVELS 3 OR 4
CORROSIVENESS	pH OF 6 TO 9	pH OF 5 TO 6 OR 9 TO 10	pH OF 3 TO 5 OR 10 TO 12	pH OF 1 TO 3 OR 12 TO 14
SOLUBILITY	INSOLUBLE	SLIGHTLY SOLUBLE	SOLUBLE	VERY SOLUBLE
VOLATILITY	VAPOR PRESSURE LESS THAN 0.1 mm Hg	VAPOR PRESSURE OF 0.1 TO 25 mm Hg	VAPOR PRESSURE OF 78 TO 25 mm Hg	VAPOR PRESSURE GREATER THAN 78 mm Hg
PHYSICAL STATE	SOLID	SLUDGE	LIQUID	GAS
WASTE MANAGEMENT PRACTICES				
SITE SECURITY	SECURE FENCE WITH LOCK	SECURITY GUARD BUT NO FENCE	REMOTE LOCATION OR BREACHABLE FENCE	NO BARRIERS
HAZARDOUS WASTE QUANTITY	0 TO 250 TONS	251 TO 1,000 TONS	1,001 TO 2000 TONS	GREATER THAN 2,000 TONS
TOTAL WASTE QUANTITY	0 TO 10 ACRE FEET	11 TO 100 ACRE FEET	101 TO 250 ACRE FEET	GREATER THAN 250 ACRE FEET
WASTE INCOMPATIBILITY	NO INCOMPATIBLE WASTES ARE PRESENT	PRESENT, BUT DOES NOT POSE A HAZARD	PRESENT AND MAY POSE A FUTURE HAZARD	PRESENT AND POSING AN IMMEDIATE HAZARD
USE OF LINERS	CLAY OR OTHER LINER RESISTENT TO ORGANIC COMPOUNDS	SYNTHETIC OR CONCRETE LINER	ASPHALT-BASE LINER	NO LINER USED
USE OF LEACHATE COLLECTION SYSTEMS	ADEQUATE COLLECTION AND TREATMENT	INADEQUATE COLLECTION OR TREATMENT	INADEQUATE COLLECTION AND TREATMENT	NO COLLECTION OR TREATMENT
USE OF GAS COLLECTION SYSTEMS	ADEQUATE COLLECTION AND TREATMENT	COLLECTION AND CONTROLLED FLARING	VENTING OR INADEQUATE TREATMENT	NO COLLECTION OR TREATMENT
USE AND CONDITION OF CONTAINERS	CONTAINERS ARE USED AND APPEAR TO BE IN GOOD CONDITION	CONTAINERS ARE USED BUT A FEW ARE LEAKING	CONTAINERS ARE USED BUT MANY ARE LEAKING	NO CONTAINERS ARE USED

Page 2 of 2

TABLE OF CONTENTS

Page

Foreword

Executive Summary ES-1

List of Figures vi

List of Tables vii

List of Acronyms viii

Introduction 1

CHAPTER ONE. HAZARDOUS WASTE CATEGORIZATION BY THE ENVIRONMENTAL PROTECTION AGENCY 6

1.1 Introduction 6

1.2 Resource Conservation and Recovery Act Authority and Legislative History 7

1.3 Consideration of Degree of Hazard in the Proposed RCRA Regulations

  1.3.1 Criteria for Listing Wastes as Hazardous 17

1.4 Comments on the Proposed RCRA Regulations 24

  1.4.1 Response to Comments and Rationale for the Federal Regulations 28

  1.4.2 Feasibility of Establishing a Degree of Hazard System 30

  1.4.3 Accomplishment of Major Objectives of Degree of Hazard System 33

1.5 Degree of Hazard Schemes Proposed By Various Interested Parties

CHAPTER TWO. HAZARDOUS WASTE CATEGORIZATION BY STATES

2.1 Introduction 62

2.2 California Degree of Hazard System 63

INTRODUCTION

The fundamental issue examined in this report is that hazardous waste is not homogenous with respect to magnitude of hazard. Differences exist among substances that comprise hazardous waste in terms of their hazard severity, degree of risk, and impact on societal welfare and health. It follows that any and all analyses of hazardous waste management practices by the Office of Technology Assessment, U.S. Congress and policy recommendations should reflect these differences in severity among hazardous wastes.

This comprehensive study presents a summary of international and domestic literature, documents, and reports as well as interviews with government officials, industry executives and scholars on the issue of categorization of hazardous waste by hazard degree classes and/or similar hazard or risk severity classifications. However, comprehensive categorization schemes of hazardous wastes in terms of degree of hazard have not been developed in the United States or abroad.

The scarcity of hazardous waste categorization schemes in terms of hazard severities is well recognized in literature and well known by personnel working in hazardous waste management. Support for this assertion is found in a recent document prepared by the Office of Science and Technology Policy, Executive Office of the President.[1/]

[1/] Louis H. Blair, Carl R. Gerber & Leonard C. Slosky. "Scientific and Technical Needs for Hazardous Waste Management". Office of Science and Technology Policy, Washington, D.C., October, 1979.

> The key problem in hazardous waste management is the lack of information on the degree of hazard to human health and the environment of various wastes and waste sites. This information is needed to help set priorities and strategies for waste management and cleanup efforts. Wastes and waste sites do not fall into two categories -- harmful and harmless -- but rather pose a spectrum of harm or hazard to human health and the environment. Consequently, it is important not only to know the hazard posed by a waste (or waste site), but also how it relates to the hazards posed by other wastes (or sites) and the likelihood of human exposure and of environmental contamination. Presently, only an extremely crude yardstick can be used to determine the degree of hazard. Though some knowledge is available about the effects of pure chemicals, virtually nothing is known about the effects of chemical mixtures on health and the environment; the ways that wastes migrate through soils, ground and surface waters, and air; the likelihood of exposure to humans and to the ecosystem; and the susceptibility of specific population groups to various wastes.
>
> and
>
> The key need for immediate improvement in hazardous waste management is a set of procedures for identifying the degree of hazard posed by individual wastes and by individual waste sites. The approach should consider both the toxicity posed by the wastes and the likelihood of exposure of humans and the ecological system to the wastes. Information on the degree of hazard would facilitate comparisons of waste streams and waste sites, helping policymakers set priorities on which sites and wastes to address first to protect human health and to reduce environmental insults.

This basic theme is also emphasized by the Environmental Protection Agency (EPA) in a recent[1/] document where EPA explicitly admits that hazardous waste categorization by degree

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[1/] Environmental Protection Agency. Background Document on "Degree of Hazard". Washington, D.C., April, 1980.

of hazard cannot be accomplished readily. One of the principal reasons for this problem is the limited funding allocated to this task by the Agency (Table 1).*

The statement of work for this research effort consists of the following four tasks:

TASK 1. Undertake a comprehensive literature review of non-nuclear hazardous waste categorization and evaluation methodologies by types of severity, health effects, duration of hazard, and other pertinent characteristics. "Hazardous waste" in this context will include both specific substances and generic processes.

This review will include reports, documents and other relevant material published by various agencies in the United States such as EPA, National Academy of Sciences, Council on the Environmental Quality, Industrial Hygiene Association, and others; by international organizations such as the Environmental Directorate of OECD, World Health Organizations, United Nations Environmental Program, and United Nations Industrial Development Organization (UNIDO); and by scientists and scholars working in academic, private research laboratories, and related research institutions.

Of particular concern in this task will be analysis of respective similarities, differences, advantages, and disadvantages of hazardous waste categorization appproaches and the underlying basis for the categorization.

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*All Tables can be found at the end of this report.

The following chapter of this report satisfies the requirements of Task 1.

Chapter 1 presents a comprehensive literature review regarding hazardous waste categorization by EPA. Comments made to this Agency with regard to the proposed rules and regulations on Resource Conservation and Recovery Act of 1976 are included.

Chapter 2 presents a literature review of hazardous waste categorization schemes by those States which have developed such schemes.

Chapter 3 presents a literature review of hazardous waste categorization schemes developed by various non-government organizations in the United States.

Chapters 4 and 5 present a review for international organizations and international non-government organizations. However, these sources have not yet developed hazardous waste categorization schemes. Considerable planning and related activity have been undertaken by these organizations, as summarized briefly in Chapters 4 and 5. Further details are presented in Appendices A and B.

TASK 2. Undertake a comprehensive literature review of non-nuclear hazardous waste categorization schemes by types of severity, health effects, duration of hazard and other pertinent characteristics after the hazardous wastes have been disposed, i.e., in situ of depository.

This review will differentiate the in situ severity of hazardous wastes by final disposal medium such as terrestrial surface dumping, subsurface burial, and deep well injecting.

Results of this task are reported in Chapter 6.

TASK 3. Undertake a comprehensive review of all pertinent risk analysis related to non-nuclear hazardous wastes. Of particular concern is the analysis of whether or not the disposal of such wastes and the manner of disposal are accomplished in accordance with the finding and recommendations specified in the risk analysis.

Comprehensive review of various risk analyses clearly indicates that risk analysis up to the present time contributes little to the categorization of hazardous wastes. Chapter 7 is a discussion of this issue.

TASK 4. On the basis of findings in the first three tasks, prepare a critical review of existing non-nuclear hazardous waste severity categorization schemes for hazardous waste per se as well as for severity in disposal sites. Indicate all deficiencies in the present categorization schemes by type of hazardous waste and disposal medium.

Critical analysis of the literature reviewed is presented in Chapter 8.

CHAPTER ONE

HAZARDOUS WASTE CATEGORIZATION BY THE ENVIRONMENTAL PROTECTION AGENCY

1.1 INTRODUCTION

The Environmental Protection Agency has undertaken research and analyses efforts that lead to an admittedly limited classification of hazardous wastes. Their early 1974 classification schemes of degree of hazard are relatively crude and essentially classify hazardous wastes into three categories: toxic chemical; radioactive and biological wastes.

At the same time, the Agency began to complete lists of either hazardous wastes and/or substances that presented certain hazards to the society, without differentiating these wastes as to the degree of risk or hazard. The EPA's concern with hazardous wastes in mid-1970's resulted in two additional reports. The Agency published a listing of "High-Hazard Compounds" (Table 2) which presumably presents higher degree of hazard to the public than others; the Agency also began to analyze the industrial origin and magnitude of hazardous waste[1/].

EPA's effort to categorize hazardous waste increased significantly during and after the passage of the Resource Conservation

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[1/] See N.G. Cheremisinoff, Industrial and Hazardous Wastes Impoundment. Ann Arbor, Michigan, 1979.

and Recovery Act of 1976 (RCRA). In fact, provisions of RCRA have been the catalyst in recent and present hazardous waste categorization efforts by the Agency.

1.2 RCRA AUTHORITY AND LEGISLATIVE HISTORY

Subtitle C of the Solid Waste Disposal Act, as substantially amended by the RCRA, creates a comprehensive "cradle-to-grave" control system for the management of hazardous waste. The system is designed to protect human health and the environment from improper management of such wastes. Hazardous waste, as defined in Section 1004(5) of RCRA, means "a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may -

> (A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or
>
> (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed."

No specific mention is made in this definition or elsewhere in RCRA of the term "degree of hazard" of wastes. Furthermore, there is no mandate in RCRA requiring that hazardous wastes somehow be classified or categorized according to the level of risk or danger to public health and the environment which they represent.

However, commentators on RCRA have argued that the above definition implicitly suggests that a degree of hazard system should be developed. They argued that the two-part definition of hazardous waste in Section 1004(5) of RCRA provides for at least two classes of hazardous wastes. They claimed that Class I should consist of those wastes which, even in small quantities, are a constant hazard in and of themselves, i.e., those which may cause or contribute to an increase in mortality or serious illness irrespective of how they are treated or stored. Similarly, Class II would consist of those wastes which may become a hazard, i.e., those wastes which may pose a substantial hazard to health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

Others have also argued that the legislative history of RCRA supports the above viewpoint. For example, they indicated that the House Committee Report on RCRA (No. 94-1491 on H.R. 14496, p. 25) sets forth the following view:

> The Committee anticipates the identification of two basic types of substances: those which are hazardous in their elemental and most common form, regardless of concentration, and those which when present in sufficient concentration or when mixed with other substances constitute hazardous waste. The criteria for identification of these substances should make such a distinction based on the danger to human health and the environment. The listing of any substances not found to be hazardous per se should be accompanied by an explanation as to when such wastes are considered hazardous. (The Report goes on to say that the explanation should clarify related factors such as toxicity, concentration and persistence.)

However, Senator Randolph, the chief sponsor of RCRA in the Senate, stated during Senate passage of RCRA amendments in 1979 that a degree of hazard approach was contrary to Congressional intent. In a Senate floor debate of the RCRA amendments, Senator Randolph stated:

> ...In the public comments on the proposed regulations, under Subtitle C, many commenters suggested schemes for the classification of hazardous waste, under Section 3001, according to the degree of hazard. Such an approach is not permissible or appropriate under Section 3001, nor does the reported bill contain any amendment which would provide that flexibility. It would be unfortunate if the Environmental Protection Agency were to repropose any of the Subtitle C regulations based on this 'degree of hazard' theory. Much time would be lost in an area that urgently needs regulation, and the approach would be unlikely to withstand judicial challenge.
>
> On the other hand, the performance standards to be established under Section 3004 should contain whatever is necessary to protect health and the environment from the hazardous waste in question, in any particular disposal method or circumstance. This is the appropriate point at which the regulations can reflect the degree of hazard of a waste or a disposal practice. That flexibility can be accomplished within the current agency consideration of the proposed regulations and the comments received, in a manner consistent with the statute. (Congressional Record, June 4, 1979)

The EPA's interpretation of the legislative mandate in RCRA is that it neither requires nor precludes development of a degree of hazard system. However, the Agency believes that the intent of Congress is more clearly expressed in the legislative history quoted immediately above, because only there is the issue specifically addressed. However, in the same Senate floor discussion, Senator Lloyd Bentsen emphasized that wastes should be classified according to their "degree of hazard".[1/]

[1/] Congressional Record - Senate, June 14, 1979 at S-6821.

> I have a further concern with the Environmental Protection Agency's hazardous waste regulations. As I said before this body on May 16, Congress should consider whether these regulations properly focus on degree of hazard. Rather than classify the potential hazard in particular situations, the Environmental Protection Agency is proposing a "pass-fail" test which would determine whether or not a waste is hazardous. This arbitrary "pass-fail" determination does not adequately recognize the varying degrees of hazard potential of wastes or varying circumstances of wastes ultimate containment.
>
> As a consequence, volumes of wastes which would have little or no impact on health and the environment, could be ruled "hazardous" under the proposed Environmental Protection Agency regulations. Considering the hazardous waste disposal sites are already in short supply and that it is becoming more and more difficult to establish new disposal sites, I believe that Congress should instruct the Environmental Protection Agency to concentrate its regulatory efforts on those categories of wastes which represent severe and pressing hazards. Moreover, I would seriously recommend that the Environmental Protection Agency consider developing a system of categorizing hazardous wastes according to the degree of potential hazard to health and the environment. I believe that such discretion exists under the existing law.

In response, Senator Randolph replied:

> I understand the Senator's concern on these issues. I agree that the Environmental Protection Agency should exercise the flexibility in the act to make performance standards for facilities reflect the potential risk of the waste in question and the particular disposal practice.

The EPA expended considerable effort and significantly discussed the definition of "hazardous waste." While much of the background discussions surrounding this definition is not available in public documents, fragmentary evidence is available from public statements made by some of the Agency's participating staff.[1]

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[1] Prentiss Anne Allen, Attorney/Advisor, Office of Solid Waste, EPA. "The Definition of Hazardous Waste" T.F.P. Sullivan Resource Conservation and

The Subcommittee on Oversight and Investigations of the Committee on Interstate and Foreign Commerce also had a number of questions pertaining to the identification of hazardous wastes. The following summary of principal issues is quoted in full from a report[1] by this Subcommittee:

> EPA's proposed rules for Section 3001 establish a means by which hazardous wastes will be defined, either by specific listing or through the characteristics of the waste. The proposed regulation identifies the following eight characteristics of hazardous waste:
>
> 1. Ignitability.
> 2. Corrosivity.
> 3. Reactivity.
> 4. Toxicity (using an extraction procedure designed to determine the pollutants that could migrate from a waste when disposed in an open dump environment).
> 5. Radioactivity.
> 6. Infectiousness.
> 7. Phytotoxicity.
> 8. Teratogenicity and mutagenicity.[2]
>
> If a waste is not already labeled as hazardous through the listing procedure, a generator of waste must test it to determine if it contains hazardous features. However, the current regulations only require testing for the first four of the above-identified characteristics because EPA states that they are the only ones for which the Agency confidently believes test protocols are available.[3]
>
> The Subcommittee disagrees with the failure to require testing for all eight characteristics. Even though there may be no simple, well-accepted tests that identify all wastes which are oncogenic, mutagenic, teratogenic, or bioaccumulate, there are currently tests which yield useful information regarding such characteristics. In

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Recovery Act: A Compliance Analysis, Government Institutes, Inc., Washington, D.C., 1979.

[1] Hazardous Waste Disposal Report together with Additional and Separate Views by the Subcommittee on Oversight and Investigations of the Committee on Interstate and Foreign Commerce, 96th Congress, 1st Session, GPO, Washington, D.C., 1979, pp. 38-40.

[2] 43 FR 58950 (D-c. 18, 1978).

[3] Idem.

fact, EPA presently employs some of these tests for screening under the Toxic Substance Control Act. While we can understand EPA's concern that many of these tests are costly, we are more concerned about the fact that the presence of these characteristics in waste poses serious risks to health and the environment. Therefore, we recommend that EPA require testing for all eight characteristics. If the requirement would pose an undue burden on small companies, then we would recommend that companies that produce the same waste share the cost of testing or that Federal funds be used to share the burden.

Several groups have questioned whether this test actually simulates the likely characteristics of a dump site. The State of California, for example, in its comments to EPA, stated as follows:

> The placement of an extraction test in such a key role for evaluating toxic wastes is questioned. It is recommended that, in some cases, wastes rather than their extracts must be directly tested for toxicity; suggested changes are included. The appropriateness of the proposal extraction procedure is questioned because of the dilution procedures used. 1/

The EPA also has proposed that a substance should be considered a hazardous waste if it appears on one of the following lists: EPA's Selected Cancelled and REPAR Pesticides; Department of Transportation Classification Poison A, Poison B, and ORM-A Substances; Selected Priority Pollutants; Center for Disease Control Classification of Etiologic Agents, or if it is identified on EPA's hazardous waste stream list. 2/ The Subcommittee is concerned that EPA's proposed list leaves off wastes from a number of know carcinogens, such as asbestos and Tris. We believe that the California approach is better. It stipulates

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1/ Statement of Harvey F. Collins, Acting Chief, Hazardous Waste Materials Management Section. California State Department of Health Services, Attachment 1, p.1, before the Subcommittee on Oversight and Investigation, June 19, 1979.

2/ 43 FR 58962 (Dec. 18, 1978).

> that if certain chemicals appear in the waste at levels over those set by the State, the waste must be considered a hazardous waste. California regulates the presence of over 800 chemicals in this manner. 1/
>
> EPA notes that 'even after promulgation of these rules neither the set of characteristics nor the list are intended by the Agency to be static. Both may be added to or changed by the Agency through the rulemaking process as information develops. 2/
>
> The proposed rules note that RCRA itself provides two procedures whereby additional wastes or waste characteristics may be added. First, Section 3001(c) provides that State governors can petition the Administration 'to identify or list a material as a hazardous waste'. Second, Section 7004 provides that any person may petition the Administrator for change in the regulations.
>
> Although EPA has built in numerous safeguards to assure that the regulations will not be 'static' and that the definition of hazardous waste is flexible and will, therefore, cover the great majority of known hazardous wastes, we are concerned about EPA's failure to include a more comprehensive list of toxic substances in its regulations now. This can and should be done. We are also concerned that wastes should be tested for all 8 characteristics of hazardous waste to the greatest extent possible and that the test for toxicity be the best available one.

As the above quote indicates, Congressional hearings with regard to the RCRA focused principally on the definition of hazardous waste. Waste categorization by degree of hazard was discussed to a very limited extent and then only in terms of waste disposal facility standards.

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[1] Title 22, Section 62081(d) of the California Administrative Code.

[2] 43 FR 58950 (Dec. 18, 1978).

1.3 CONSIDERATION OF DEGREE OF HAZARD IN THE PROPOSED RCRA REGULATIONS

The regulations proposed on December 18, 1978, pursuant to the authority in Section 3001 of RCRA, provided for placing wastes in one of two categories: those that were hazardous, and therefore require management in accordance with Subtitle C; and those that were not hazardous, and therefore required management in accordance with Subtitle D. Subpart A of the proposed regulations defined as hazardous those wastes which failed the ignitability, corrosivity, reactivity or toxicity characteristics as defined in §250.13 of Subpart A or were specifically listed in §250.14. The regulations in Subparts B and C proposed a uniform set of regulations for the generation and transport of the hazardous wastes. The regulations proposed in Subpart D of Part 250 set forth the standards necessary for treatment, storage, or disposal of hazardous wastes.

When Subpart A regulations were initially developed, the Agency investigated the feasibility of using a degree of hazard system in defining hazardous wastes. However, the Agency was unable to develop a comprehensive, technically supportable system for defining the degree of hazard of a waste and the Agency felt that any general decisions regarding the degree of hazard of wastes were inherently arbitrary. The Agency also did not believe it was possible to write national standards that would associate different management requirements with different defined levels of hazard.

The proposed Subpart D standards did prescribe, however, different requirements for certain types of classes of hazardous waste. The most obvious example was in Section 250.46 of Subpart D where the Agency defined certain "special wastes" that appeared to present unique management problems due to their large volume. These wastes included the hazardous portions of cement kiln dust, utility wastes (ash and sludges), phosphate mining and benefication waste, uranium and other mining waste, and gas and oil drilling muds and oil production brines. The regulation proposed deferral of comprehensive standards for these wastes pending completion of studies defining appropriate management requirements. For the interim, a limited set of management standards for those wastes was proposed. In discussing the rationale for creating this special category of hazardous wastes, the preamble to the proposed regulations referenced several factors, including: large volume and thus, technical impracticability of some of the proposed standards; lack of information about current management practices and their environmental effects; and, low level of hazard.

The latter statement was not an attempt to specifically categorize the hazard level of these wastes or rank them in any rigorous way. However, it did reflect the Agency's belief that these wastes were relatively lower in hazard than many other wastes. However, in its final form, Subtitle C no longer contains such a group of "low hazard" wastes, and thus the special waste category has been dropped from the final regulations.

Other examples were in the proposed regulations of differentiating between various types of classes of wastes, depending on their properties. For example, Subpart D specified different incinerator conditions for various classes of wastes.

Other types of waste were also singled out in the proposed regulations for special management considerations. For example, special requirements were specified for storage, treatment, and disposal of ignitable, reactive, and volatile wastes. Similarly, special requirements for land disposal of liquid wastes were specified. These different standards or restrictions were placed on certain classes of wastes depending on their properties or characteristics, but not necessarily on their level of hazard.

In addition, Subpart D standards included variance procedures designed to allow for alternative management approaches on a case-by-case basis where compatible containment or destruction to that specified in the regulations could be demonstrated. These variances allowed for limited tailoring of management standards based on the circumstances of a particular waste, management technique and site conditions.

However, in the final RCRA regulations, the EPA simply listed categorized hazardous wastes from the following three categories:

1. Hazardous Wastes - Generic
   - Hazardous waste from nonspecific sources (see Table 3)
   - Hazardous waste from specific sources (see Table 4)

2. Discarded commercial chemical products, off-specification species, container and spill residues thereof (see Table 5); and
3. Commercial chemical products or manufacturing chemical intermediates (see Table 6).

For practical purposes, this means that the Agency did not categorize hazardous wastes by degree of hazard but simply chose to list hazardous wastes originating from the three sources indicated above.

1.3.1 Criteria for Listing Wastes as Hazardous

A brief discussion follows of the criteria used by EPA for listing the hazardous wastes in Tables 3, 4, 5 and 6. In general, a waste must have one of the following four characteristics to be classified as hazardous waste:

1. ignitability;
2. corrosivity;
3. reactivity; and
4. EP toxicity.

1. Characteristic of Ignitability. A solid waste exhibits the characteristic of ignitability if a representative sample of the waste has any of the following properties:

a. It is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume, and has a flash point less than 60°C (140°F), as determined by a Pensky-Martens Closed Cup Tester, using the test method specified in ASTM Standard D-93-79, or a Setaflash Closed Cup Tested, using the test method specified in ASTM standard D-3278-78, or as determined by an equivalent test method approved by the Administrator.

b. It is not a liquid and is capable under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard.

c. It is an ignitable compressed gas as defined in 49 CFR 173.300 and as determined by the test methods described in that regulation or equivalent test methods approved by the Administrator.

d. It is an oxidizer as defined in 40 CFR 173.151.

e. A solid waste that exhibits the characteristic of ignitability, but is not listed as a hazardous waste in Subpart D, has the EPA Hazardous Waste Number of D001.

2. Characteristic of Corrosivity. A solid waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties:

a. It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5, as determined by a pH meter using either the test method specified in the "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods", or an equivalent test method approved by the Administrator.

b. It is a liquid and corrodes steel (SAE -020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of $55^{\circ}C$ ($130^{\circ}F$) as determined by the test method specified in NACE (National Association of Corrosion Engineers) Standard TM-01-69 as standardized in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods", or an equivalent test method approved by the Administrator.

c. A solid waste that exhibits the characteristic of corrosivity, but is not listed as a hazardous waste in Subpart D, has the EPA Hazardous Waste Number of D002.

3. Characteristic of Reactivity. A solid waste exhibits the characteristic of reactivity if a representative sample of the waste has any of the following properties:

a. It is normally unstable and readily undergoes violent change without detonating.

b. It reacts violently with water.

c. It forms potentially explosive mixtures with water.

d. When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.

e. It is a cyanide or sulfide-bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.

f. It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.

g. It is readily capable of detonation or explosive decomposition or reaction at standard temperatures and pressure.

h. It is a forbidden explosive as defined in 49 CFR 173.51, or a Class A explosive as defined in 49 CFR 173.53, or a Class B explosive as defined in 49 CFR 173.88.

i. A solid wastethat exhibits the characteristic of reactivity, but is not listed as a hazardous waste in Subpart D, has the EPA Hazardous Waste Number D003.

4. Characteristic of EP Toxicity.

a. A solid wast exhibits the characteristic of EP toxicity if, using the test methods described or equivalent methods approved by the Administrator under the procedures set forth, the extract from a representative sample of the waste contains any of the contaminants listed in Table 7 at a concentration equal to or greater than the respective value given in that Table. Where the waste contains less than 0.5 percent filterable solids, the waste itself, and filtering, is considered to be the extract for the purposes of this section.

b. A solid waste that exhibits the characteristic of EP toxicity, but is not listed as a hazardous waste in Subpart D, has the EPA Hazardous Waste Number specified which corresponds to the toxic contaminant causing it to be hazardous.

The type and kind of arguments advocated by the EPA for classification of wastes as hazardous can be readily seen from the following material contained in the Agency's comments.

"Basis for Listing Toxic Wastes.[1]

> For hazardous wastes listed because they meet the Criteria of toxicity, the discussion of the basis for listing identifies the waste constituents of concern, whether these constituents are present in significant concentration, and the hazards associated with each waste constituent. The discussion then addresses whether these waste constituents, if the wastes are managed improperly, could migrate from waste management sites, persist in the environment, and reach environmental receptors so as to cause substantial hazard. The analysis generally follows a physical continuum; whether waste constituents are inherently capable of migrating from the matrix of the waste in concentrations sufficient to cause substantial hazard, whether waste mismanagement could lead to environmental release of the migrating waste constituents, and whether waste constituents are mobile and persistent enough to reach environmental receptors and cause substantial hazard upon environmental release. In some cases, actual damage incidents involving the waste or waste constituents demonstrate empirically that waste constituents may migrate, persist, and cause substantial harm if mismanaged.
>
> It must be emphasized that in making listing determinations, the Agency's principal focus is on the identity of the waste's constituents, and on constituent concentrations in the waste and the nature of the toxicity presented by the constituents. Where a waste contains significant concentrations of hazardous waste constituents, the Agency is likely to list the waste as hazardous unless it is evident that the waste constituents are incapable of migrating in significant concentrations even if improperly managed, or that the waste constituents are not mobile or persistent should they migrate. This is particularly true where the waste constituents include suspect or proven carcinogens.
>
> The Agency therefore does not seek to demonstrate that waste constituents will migrate and persist in sufficient

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[1] From: "Identification and Listing of Hazardous Waste," Environmental Protection Agency, Part III, Federal Register, May 19, 1980.

concentrations to cause substantial hazard. Rather, fate and transport information is relevant to show that the potential for harm inherent in the waste (by virtue of its composition) will not eventuate. But, as stated, there must be a very strong likelihood that hazardous constituents are unable to migrate or persist to cause substantial harm before the Agency will decide not to list a waste.

The Agency believes that this methodology is fully in accord with statutory requirements. Thus, this approach accords with the requirement of Section 3001(a) that environmental fate be considered in identifying wastes as hazardous. At the same time, the key focus is on the inherent potential of waste constituents to cause substantial harm, in accord with the definition of hazardous waste, which requires only that a waste "may pose a substantial present or potential hazard" to be hazardous.

The Agency anticipates arguments that these toxicity listing determinations are made on the basis of inadequate data, and that listings be deferred until further information is gathered. EPA recognizes that these listing determinations are essentially qualitative judgments, generally involving expert assumptions based on available physical data rather than precise field determinations of waste composition or of how the wastes will act under identified conditions. However, the statute requires only that a qualitative judgment be made, namely that the wastes, if mismanaged, pose sufficient potentiality of hazard to warrant careful regulation. The Agency believes that it has compiled sufficient information on which to make this judgment. Nor would the delay necessary to compile in-depth (though quite likely cumulative or redundant) information on potentially hazardous wastes be sufferable in light of the urgent need for rapid implementation of the hazardous waste management program.

Basis for Listing Ignitable, Corrosive, Reactive or EP Toxic Wastes.

The basis for listing ignitable, corrosive, or reactive wastes is much simpler. These wastes, to be listed, must possess the appropriate characteristic, and the listing discussion is directed toward making this demonstration.

Legal Authority to List Wastes Generically. Although Congress clearly intended to distinguish the promulgation of hazardous waste characteristics from the listing of hazardous wastes, there is no clear indication that Congress further intended to limit the Administrator's discretion by precluding listing of classes of wastes. In the Agency's view, a class of wastes may be listed generically so long as most of the wastes in the class are typically or frequently hazardous, and so long as the listing description is sufficiently specific and particularized for individual generators to determine whether their wastes streams are included within the listing.

Thus, Secion 3001(a), far from prohibiting listing of wastes by classes, simply distinguishes the use of criteria to identify hazardousness characteristics and to identify listed hazardous wastes.

The Administrator shall . . . develop and promulgate criteria for identifying the characteristics of hazardous waste, and for listing hazardous waste . . .

Section 3001(b) carried forward this distinction:

[T]he Administrator shall promulgate regulations identifying the characteristics of hazardous waste and listing particular hazardous wastes. . . Such regulations shall be based on the criteria promulgated under subsection (a). . .

To argue that Section 3001(b) was intended to bar any listing of wastes by class consequently reads far too much into the language of that provision. Indeed, possessed extremely hazardous properties. To account for these substances, EPA has established a new criterion for listing which examines the potentially lethal capacity of chemical substances in very small quantities.

Applying this criterion to the proposed lists of chemicals products has led the Agency to list 122 substances. The regulatory language has been clarified to restrict the application of this section to chemical products, or their off-specification species, and not to wastes which contain these materials as constituents. Because of their acutely hazardous nature, however, containers and inner liners which contained these materials and spill cleanup debris and residues resulting from spill of these materials are also included.

Accordingly, the Agency has adopted very low exclusion levels for these chemical products and their off-specification variants, containers and inner liners which contained these materials, and spill residues and debris. The selection of these levels reflects the judgment of the Agency that, although even lesser quantities may be hazardous, the levels selected, on the basis of probable exposure scenarios, are sufficient to minimize the threat to human health and the

> environment while enabling the Agency to implement and enforce these regulations. The one kilogram level for the chemicals will, in the Agency's judgment, bring under full regulation virtually all of the substances being thrown away. The quantity limit for containers which have not been triple rinsed (20 liters) represents the Agency's judgment of probable exposure and consequential injury from the use of discarded containers. The Agency has records of damage incidents resulting from improperly disposed containers that occurred when people salvaged large containers for such uses as garbage containers and barbecue pits. The levels chosen for inner liners and spill residue and debris represent the same type of judgment based on probable exposure. 1/

As indicated, the EPA, using material from past studies and the four hazardous waste characteristics of ignitability, corrosivity, reactivity and EP toxicity, has classified over 600 wastes as hazardous. All of these wastes as indicated by the Agency's regulations represent the same uniform hazard: the Agency has not attempted to classify these hazardous wastes in terms of severity or other attributes of the degree of hazard. In fact, the Agency has admitted that such classification is not possible.

Support of this significant assertion can be found in EPA's own statement[1/]:

> Inability of the Agency to Use Degree of Hazard. Because the Agency was unable to use quantity in determining whether a waste is hazardous, it considered using degree of hazard in determining the appropriate quantity exclusion level. Commenters heavily supported establishing exclusion limits based on degree of hazard of various wastes. These suggestions were part of a broader set of comments which recommended that the Agency establish a degree of hazard system that placed wastes into two or more levels of hazard depending on the risk that those wastes present to public

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[1/] "Identification and Listing of Hazardous Waste", Environmental Protection Agency, Part III, Federal Register, May 19, 1980, pp. 33103-33104.

> health and the environment. Commenters argued that such a system could be used as a basis for phasing regulatory coverage, tailoring waste management standards, and establishing small quantity exclusion levels.
>
> The Agency's response to the full scope of the degree of hazard proposals is included in the preamble to the Parts 264 and 265 regulations being promulgated today. As explained there, the Agency has not adopted a degree of hazard system in the final regulations. Among other reasons, the Agency concluded that none of the degree of hazard systems suggested by commenters, nor any it could itself conceive, is capable of comprehensively distinguishing different degrees of hazard among the myriad of hazardous wastes without application of very subjective judgment. This precluded establishing small quantity exemptions based on a hierarchy of hazard levels. While the Agency has not found it possible to establish a comprehensive hazard ranking system, the Agency has attempted on a limited basis to make hazard distinctions in establishing small quantity cutoffs. The Agency has established very low exclusion limits for certain very acutely toxic or otherwise hazardous chemical products (if discarded), off-specification derivatives of those products, and the product containers and spill residues. The Agency may in the future establish specific (low) exclusion limits for other highly hazardous wastes on a case-by-case basis.

1.4 COMMENTS ON THE PROPOSED RCRA REGULATIONS

During the comment period on RCRA regulations, the Agency received several hundred comments suggesting that the regulations incorporate a degree of hazard system. Most commenters advocated adoption of a degree of hazard system for the identification and management of hazardous wastes based on the relative risk presented by the waste. However, the comments differed on factors such as the complexity of the system, the criteria for establishing a hierarchy of risk, and the relationship of the resulting classes to the waste management scheme. The majority of comments supporting the degree of hazard concept did not propose a specific approach for carrying it out.

The degree of hazard proposals were based on concerns about the priority of implementation and the economic burdens that might, in the commenter's view, be imposed if the same standards were applied to relatively low and high hazard wastes. Some commenters argued that the Agency should prioritize its implementation of the regulations, particularly because of limited disposal capacity, and that such phased implementation could only be accomplished with a degree of hazard system. Others argued that without a degree of hazard system, all wastes would be subjected to the same management requirements, resulting in over-regulating some wastes, and thereby imposing unnecessary economic burdens. Listed below is a summary of the major categories of comments received:

1. The legislative history of RCRA shows that Congress intended that a degree of hazard system be developed. Commenters pointed to the definition of a hazardous waste in RCRA, and to certain legislative history.
2. It is inappropriate to have only one level of hazard and thereby class both "extremely" hazardous waste and "slightly" hazardous waste in the same category. By extremely hazardous, the commenters usually meant extremely toxic wastes, although many commenters did not suggest limits defining various levels of hazard.
3. A degree of hazard system is necessary to provide for tailoring and flexibility in the management standards for treating, storing and disposing of hazardous waste. Without this flexibility and tailoring of standards, the regulated community will be subject to severe costs and administrative burdens from appropriate or unnecessary regulation of some wastes. Commenters argued that

while in theory the variance procedures, such as those provided in Subpart D of the proposed regulations, provide for waste-specific flexibility, permit writers are likely to be conservative and, thus, reluctant to apply variances.

4. A degree of hazard system is needed in order to phase the regulations and alleviate the projected lack of facility capacity. Commenters suggested that the "extremely hazardous" waste be regulated immediately, and as capacity became available, the "less hazardous" portion could be brought into the system. Many of the commenters were concerned that without such a system, the Subtitle C management facilities would be inundated with materials or wastes which were not "truly" hazardous. Another element to the phasing argument presented in the comments was that a degree of hazard system would allow EPA and the States to establish priorities for hazardous waste management review. Limited resources could then be concentrated on those wastes which were "truly hazardous" in implementing the regulations.

5. The degree of hazard of wastes should be used as the basis for establishing quantity thresholds in providing exemptions for wastes from small quantity generators. This comment was addressed primarily to the proposed rule that a quantity exemption be established for small volume waste generators to avoid potentially overburdening the system administratively.

6. With a degree of hazard system, the opposition from the public to siting hazardous waste management facilities for the "less hazardous" wastes would be reduced because those wastes could be presented and labeled as not being "extremely hazardous". This would allow additional time

in which new sites could be developed and existing sites upgraded.

7. Considerable precedent exists within the Agency for developing a degree of hazard system. Several commenters pointed out that in EPA's recently reproposed regulations under Section 311 of the Clean Water Act a 5-tiered approach is used in setting "reportable quantities" of hazardous substances (44 FR 10271, February 16, 1979). As stated in the preamble, the commenters argued, the volume of each substance which is "reportable" was determined based upon EPA's estimate as to the amount which "may be harmful" when discharged or spilled. These same commenters also pointed out that under TSCA, the Agency has developed a list of up to 50 substances which by reason of their relative toxicity, persistance, and presence merit closer scrutiny.

8. The hazard presented by a waste is a function of its chemical/physical parameters; (i.e., its intrinsic properties) hence the risk classification should be based on a quantification of these parameters. Commenters argued that properties such as persistence, bioaccumulation, and vapor pressure should be integrated into the hazard classification system. For example, a toxic-persistent-bioaccumulative waste would be more hazardous than a toxic waste that does not exhibit these other properties.

9. The hazard posed by a waste is a function of its management. Therefore, wastes should be classified according to how they are managed. Commenters argued that some wastes pose no risk when handled correctly or even under routine handling, while other wastes are always dangerous and should not be included in the same class with those which are only dangerous under certain

conditions. A number of these commenters took the position that wastes which are properly managed should not be considered hazardous and controlled under Subtitle C. Several commenters argued that intrinsic hazard and management should be combined in assessing the degree of hazard of a waste.

10. A number of commenters suggested specific degree of hazard schemes, focusing either on waste classification only or both waste classification and management requirements.

1.4.1 Response to Comments and Rationale for the Federal Regulations

The EPA, in principle, agreed with the commenters' assessments of the objectives of benefits associated with a degree of hazard system. According to the Agency, the purpose of such a system would be to provide the following benefits in the regulation of hazardous wastes:

- Phasing of regulations to address first the wastes which present the greatest risk to public health and environment.
- Tailoring of management standards to the properties of wastes so that adequate protection of public health and the environment can be achieved without overregulating some wastes (and unnecessarily increasing the economic impact of the regulations) or underregulating others (and not sufficiently protecting public health).

- Setting quantity threshold levels below which small quantities of wastes could be exempted from some or all of the Subtitle C management requirements without significant impact on public health and the environment.

The Agency further states that the final regulations, when promulgated in full, will achieve each of these objectives. Significant changes from the proposed regulations have been, or will be made to make this possible, most notably by structuring of a highly flexible approach for determining management requirements for wastes; this approach will be promulgated in the next phase of the regulations. However, the Agency had decided not to adopt a degree of hazard system as the means of achieving these objectives, for the following reasons:

- The Agency does not believe that any of the degree of hazard systems suggested by commenters are technically and legally defensible, nor has the Agency itself found it feasible to design such a system.
- The Agency believes that preferable ways exist of achieving the objectives of a degree of hazard system, particularly the tailoring of management requirements, and the final regulations are structured to achieve those objectives. Thus, a degree of hazard system is unnecessary.

These points made by the Agency are discussed in detail below, presenting the Agency's views.

1.4.2 Feasibility of Establishing A Degree of Hazard System

There are two key elements in a degree of hazard regulatory system:

1. Classification of hazardous wastes according to their level of hazard, i.e., risk to public health and the environment.
2. Establishing waste management standards tailored to the level of hazard.

1. Classification of Wastes According To Their Level of Hazard. The central element of a degree of hazard system is a classification of hazardous wastes according to their level of hazard or risk to human health and the environment. The Agency is convinced that all of the degree of hazard classification schemes suggested by commenters or otherwise considered by the Agency are extremely judgmental, difficult to support technically, and therefore prone to be considered arbitrary.

Many commenters proposed that a degree of hazard system should be based on management practices rather than, or in addition to, intrinsic hazard. The Agency concurs with the latter group of commenters who suggest that the risk to public health of a waste depends on the potential for exposure as well as intrinsic hazard.

Exposure assessments depend on many situation-specific factors that determine the pathways through which exposure may occur, e.g., the hydrogeology, proximity and use of ground water and surface water, biodegradability of a waste, or attentuation by the soil. Furthermore, different management approaches such as landfill, land treatment, incineration, and treatment exhibit different potential exposure pathways. The Agency had found such exposure assessments difficult to make in simply defining a waste as hazardous when mismanaged. Exposure assessments, made for the purpose of constructing a multi-level degree of hazard system, would prove enormously complicated, if not impossible.

Although the Agency was convinced that hazard levels of all wastes cannot be classified in a rigorous and comprehensive way, some general hazard distinctions are possible on a case-by-case basis when sufficient information and justification are available. In the regulations, the Agency had not failed to recognize the relative hazard levels associated with wastes. For example, the list of commercial products in 261.33 and the list of hazardous substance in Appendix VIII of Part 261 are wastes or substances the Agency believes are relatively high in risk to public health.

The Agency had considered this fact in establishing exclusion levels for hazardous wastes from small quantity generators. For example, wastes from the list in 261.33 have much lower quantity exclusion levels than the 1000 kg/mo exclusion for other wastes. Significantly, however, the Agency defined and justified lower quantity exclusions for only a limited number of "high hazard" wastes.

Thus, although the Agency had not found it feasible or desirable to establish a rigorous and sophisticated degree of hazard system, the consideration of hazard is evident in various parts of the regulation, and distinctions in hazard levels have been made in those instances where necessary and justifiable.

2. Tailoring Management Standards To Different Degrees of Hazard. A major objective of a degree of hazard system is to provide a basis for tailoring of management standards. Commenters argued that this tailoring would avoid unnecessary management requirements and costs for some wastes which may not require the same level of stringent management requirements and costs needed for other more hazardous wastes.

The Agency agreed with commenters that the regulations should provide for flexibility to achieve tailoring of management requirements. However, the Agency did not believe that the best approach to tailoring is to prescribe nationally applicable requirements based on the degree of hazard of waste.

The Agency assumed that management requirements for protecting public health and the environment in disposing of hazardous wastes can best be based on the unique properties of a waste (i.e., the type or class of hazard it presents) and the local site conditions rather than its level of hazard. Several requirements dealing with the type or class of hazard were incorporated into the proposed regulations. Such requirements are included in the final regulations, and may be expanded in the Phase II regulations.

The other major factor which should influence the specific management requirements for a waste are the local site conditions.

The degree of hazard or level of risk a waste presents can also influence management requirements in some instances, but generally is much less adaptable to specification of tailored management requirements than the type or class of hazard and local site conditions.

Thus, the Agency did not feel that it had the necessary technical information and criteria to develop a technically supportable set of national standards to rank wastes by degree of hazard and to tailor management requirements to those hazard levels rather than to the waste's actual properties and the site conditions. The Agency believes that development of such a system would require highly subjective and technically unsupportable judgment. Construction of a degree of hazard classification system is not the appropriate means of achieving tailoring of waste management standards.

The Agency believes that the regulatory structure adopted in the current (Phase I) and planned (Phase II) regulations will accomplish the objectives of a degree of hazard system, including tailoring of management standards, while avoiding the problems associated with such a system.

1.4.3 Accomplishment of Major Objectives of Degree Of Hazard System

Described below are ways in which the regulations accomplish the three major objectives of a degree of hazard system: phasing of regulatory coverage; tailoring of management standards; and setting small quantity exclusion levels.

1. Response to phasing. Cognizant of the Congressional admonition that the hazardous waste problem should be addressed

as quickly as possible, the Agency believed that a large amount of phased implementation on a waste-specific basis, as suggested by many commenters, may not be in keeping with Congressional intent. However, the Agency believed that some attention to phasing is necessary and desirable, given limited Agency and state resources and initially limited facility capacity for treatment and disposal.

The final regulations accomplish phasing in several ways. Some phasing is accomplished as a consequence of the process for identification of hazardous wastes in Part 261. The fact that hazardous wastes are identified through listing as well as through four self-imposing characteristics contributes to phasing. For technical reasons, EPA has not specified a broader range of characteristics for identifying hazardous wastes through generator testing. Thus, the identification of hazardous wastes through these characteristics brings under Subtitle C control a partial universe of hazardous wastes. Other wastes are brought into the system through the listing process, where a broad range of criteria are applied in determining a waste to be hazardous. Although not designed with phasing in mind, the entire structure of identification of hazardous waste contributes to phasing Subtitle C coverage over time.

Furthermore, the initial listing of wastes includes primarily wastes of generally high hazard. It is primarily from the wastes of higher hazard that EPA has been able to obtain sufficient information to support listing. The listing of commercial products in 261.33 and hazardous substances in Appendix VIII of Part 261 similarly include primarily products and substances of know significant hazard. As more information is gathered, additional wastes will be added to the list, thus phasing Subtitle C coverage by expanding the universe of hazardous wastes.

The exclusion levels for wastes from small quantity generators represent another example of phasing in the regulations. An initial general exclusion level of 1000 kg/mo has been established but the Agency expressed its intent to phase this cutoff down to 100 kg/mo. The reason for this phasing is the projected lack of Agency and State resources to effectively regulate the generators who would be brought into the regulatory system at lower cutoffs. However, much lower exclusion levels (below 100 kg/mo) were established for some wastes based on clear evidence that certain wastes present extreme hazards. The Agency expects to set additional lower cutoffs as data on specific wastes justify such action.

The phasing accomplished by the above provisions of the regulations should significantly address both Agency and State resource limitations and facility capacity limitations. However, additional attention to phasing can also be achieved in the implementation of the regulations. Each approved State and EPA Region implementing the regulations will have the flexibility to administer the permitting and enforcement process in such a way that the most severe hazardous waste problems will receive first considerations. The State and regional levels are appropriate sources for such decisions because they can best balance the mix of specific waste types, available capacity, and State and Agency resources that can be used to address the problem.

2. Response to tailoring. A desire for management standards to provide more flexibility in tailoring the management requirements to different wastes was a major factor mentioned by commenters in support of a degree of hazard system. In fact, a desire for greater flexibility in the management standards to consider waste and site-specific factors was expressed by many commenters apart from the degree of hazard issue. The Agency concurred with this objective, and believed that it will be effectively achieved by current and pending regulations. As noted, the Agency was not able to demonstrate its full response on this issue because complete technical management standards have not yet been promulgated. However, the basic framework for those standards has been determined by the Agency, and they are discussed here in that context. The Agency believed that tailoring of management requirements should be based primarily on two factors: the properties or class of hazard a waste presents; and the site-specific conditions under which it would be managed. Some potential for tailoring based on degree of hazard considerations may also be appropriate on a case-by-case basis.

In the proposed regulations, the Agency incorporated some tailoring of requirements based on type or class of hazard involved. For example, special requirements or conditions were included for ignitable, reactive and volatile wastes, incompatible wastes, liquid wastes, and wastes containing halogens. Some flexibility was provided in the variances to the regulations as specified in notes.

The final Phase II regulations will expand the tailoring of regulatory requirements based on waste properties (i.e., class of hazard) and will greatly increase the overall flexibility to tailor regulatory requirements during the permitting process. The Part 265 Interim Status Standards and the partial Part 264 standards promulgated related largely to more administrative types of requirements, and thus are not conducive to significant tailoring. However, these regulations do incorporate a significant amount of flexibility.

3. Response to setting exemption levels for small quantities. Several commenters in responding to either degree of hazard or small quantity generator issues suggested using the degree of hazard of wastes as a means of establishing a quantity exclusion level below which the generator's waste would or would not be subject to reduced Subtitle C requirements.

As explained in the preamble and background document for small quantity generators, the Agency considered hazard on a selective case-by-case basis in establishing very low exclusion levels (from 1 to 100 kg/mo) for some extremely hazardous substances. These levels are well below the general exclusion level of 1000 kg/mo. Thus, on a selective basis the Agency had considered hazard in setting administrative exclusions for small quantity generators.

Had it been feasible to develop a sophisticated degree of hazard system, the Agency might have been able to apply it to the small quantity generator issue. However, the Agency is satisfied that the approach to the small quantity issue which it has taken, i.e., a general exclusion coupled with case-by-case reductions in that exclusion, is reasonable and will be effective.

1.5 DEGREE OF HAZARD SCHEMES PROPOSED BY VARIOUS INTERESTED PARTIES

As the result of EPA's proposed RCRA regulations, a number of interested parties proposed specific degree of hazard schemes for the Agency's consideration. While many of these proposals do not merit serious discussion, some of them represent a comprehensive degree of hazard classification schemes of hazardous wastes.

The following sections summarize 12 of the more comprehensive of these proposed hazardous waste classification schemes.

1. Proposed Classification Scheme by Chemical Manufacturers Association. This scheme proposed by Chemical ManufacturersAssociation[1] proposes five categories for degree of hazard categories based on Section 3001 hazard characteristics of ignitability, corrosivity, reactivity, toxicity and on other test results.

a. Class I - High Hazard

These wastes, if improperly handled, could present a high hazard to health or the environment, and therefore, require special care in storage, handling and disposal. Such wastes would be disposed of in the most secure RCRA §3004 facilities. Included in this class would be persistent, mutagenic, and high-to-moderate acutely toxic wastes, plus wastes that presented a high hazard to drinking water supplies.

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[1] Much of the material presented is based on: Chemical Manufacturers Association. A System of Management of Hazardous Wastes by Degree of Hazard Under Subtitle C of RCRA. Washington, D.C., July 31, 1979.

Specific criteria for this class are:

1. Its extract fails the mutagenic activity test and fails a persistence test; or
2. Its extract is an organic material of high acute toxicity; or
3. Its extract is an organic material of moderate acute toxicity, and fails the accumulation potential test and fails a persistence test; or
4. The extract contains any contaminant listed in §250.13(d) of the proposed regulations at concentrations greater than or equal to 1000 times the National Interim Primary Drinking Water Standard.

b. Class II - Moderate Hazard

These wastes could present a moderate degree of hazard to health or the environment if improperly handled, but can be safely handled and disposed in a well-designed and operated hazardous waste management facility. This class would include moderate or low toxicity wastes with unusually high accumulation potentials or persistence characteristics. Ignitable-, reactive- and wastes posing moderate potential danger to drinking water sources would also fit into this class. Class II facilities would be subject to many of the same §3004 standards as Class I facilities, but where appropriate, the degree of control would be somewhat less stringent.

Specific criteria for this class are:

1. Its extract fails the mutagenic activity test, but does not fail a persistence test; or
2. Its extract is an organic material of moderate acute toxicity and either (a) fails the accumulation potential test, but does not fail a persistence test, or (b) does not fail the accumulation potential test, but fails a persistence test; or
3. Its extract is an organic material of low acute toxicity and fails the accumulation potential test and fails a persistence test; or
4. The extract contains any contaminant listed in 250.13(d) of the proposed regulations at concentrations greater than or equal to 300 and less than 1000 times the National Interim Primary Drinking Water Standard; or
5. It fails the ignitability characteristics; or
6. It fails the reactivity characteristic.

c. Class III - Low Hazard

This class includes those wastes which, although categorized as "hazardous", nonetheless represent only a minimal potential hazard to health or the environment. Included would be wastes of low toxicity, and nonaccumulative, non-persistent moderate toxicity wastes, as well as corrosive wastes and wastes of low potential hazard to drinking water.

Specific criteria for this class are:

1. Its extract is an organic material of moderate acute toxicity but does not fail the accumulation potential test and also does not fail a persistence test; or
2. Its extract is an organic material of low acute toxicity and (a) fails the accumulation potential test and passes a persistence test, or (b) passes the accumulation potential test; or
3. The extract contains any contaminant listed in 250.13(d) of the proposed regulations at concentrations greater than or equal to 100 times, but less than 300 times, the National Interim Primary Drinking Water Standard; or
4. It fails the corrosive characteristic.

d. Class IV - Special Wastes

These wastes were defined by EPA as special wastes in the proposed regulations as wastes generated in large volumes but having low hazard or unique properties.

e. Class V - Radioactive and Infectious Wastes

These wastes are designated in "special" categories, not in the sense of being high volume or low hazard, but rather as needing special consideration for proper disposal.

This classification scheme also proposes a three-tier classification system under which hazardous waste disposal facilities would be designed and operated on the basis of standards designed to achieve a degree of protection consistent with degree of hazard potentially presented by the wastes being disposed. The system does not significantly alter the boundaries of EPA's proposed "hazardous waste" definition; rather, this system further classifies hazardous wastes for disposal in an adequate, but not excessively stringent, manner. The facility classification scheme would result in facility utilization as follows:

f. Class I Facilities. Class I facilities would be designed and operated to allow safe disposal of the most hazardous waste. These wastes because of their toxicity and accumulation/ persistence properties, require a high degree of protection in handling and disposal, and a high degree of protection against significant release into the environment. Facilities receiving and disposing of Class I hazardous wastes would be required to be in essential compliance with the full scope of Section 3004 regulations.

g. Class II Facilities. Class II facilities would be designed and operated to allow safe disposal of wastes presenting a lesser degree of potential acute or chronic hazard by virtue of toxicity and accumulation/persistence properties. The criteria for differentiating Class I and Class II wastes, and the appropriate facility standards are based on the knowledge and experience of specific industrial companies. While there is a valid "break point" for defining "high hazard" and "moderate hazard", the Class I and Class II facility standards proposed herein are only slightly different. Class II wastes, with potential hazard less than those in Class I, would still be stringently controlled over a long term.

h. Class III Facilities. Class III facilities would be designed and operated to allow safe disposal of wastes representing relatively low potential hazards, or which will not persist in the environment as hazardous for appreciable periods of time. This category would include inorganic wastes not considered as a serious threat to drinking water sources, as measured by the drinking water comparison characteristics. Also included would be relatively inert materials such as low toxicity organic "tars". Class III wastes would represent a low level of hazard during handling and disposal operations, and, once landfilled, would be very unlikely to endanger surface or groundwater. Consequently, Class III facility standards are proposed that are based on good engineering practice and are aimed at minimizing release of the waste to the environment.

2. Proposed Classification Scheme #2. This classification scheme proposes a six-tier degree of hazard concept. In this system, exposure is a defined function of entry (form, quantity) and availability (movement, stability, bioconcentration); effect is defined in terms of toxicity, carcinogenicity, mutagenicity or teratogenicity. The first step in developing the classification system was to consider quantity. A hierarchy of control levels was constructed for the waste leachate in water (Table 8). This assumption was made assuming that a toxic component is disposed of through a landfill, is leached, then attenuated in surrounding soil, and finally diluted into a natural water. These control levels in water were assigned

on water-borne components (LD_{50} toxicity values for rats; LC_{50} toxicity values for fish or other aquatic species ([Table 9])). This categorization was patterned after similar schemes proposed by the Intergovernmental Maritime Consultive Organization of the U.N. (IMCO), the EPA spill regulations (Sec. 311 of the Clean Water Act), the pesticide regulation- (under FIFRA), and a classification scheme developed by the State of Washington, as well as others by the NAS, AIBS, and ASTM.

The rate of generation to be exempted from regulation as a hazardous waste was then assigned to each hazard category. A quantity of 1 kg/mo or greater of waste in Category A, 10 kg/mo in B, 100 kg/mo in C, or 1000 kg/mo in E would be subject to management as a hazardous waste. A total quantity of 10,000 kg/mo or greater of Category E would be allowed into a segregated (monolandfill) facility. Category F waste was classified as special waste, i.e., a high volume , low hazard waste which would require disposal under minimal guidelines. The stairstep classification according to quantity is shown graphically in Figure 1.* All wastes in all Categories A-F equal to or greater than the specified rates of generation would be considered hazardous and would require disposal in hazardous waste management facilities (RCRA Section 3004 facilities). All wastes in all Categories A-F less than the specified rates of generation would be considered non-hazardous for purposes of regulation and require disposal in solid waste management facilities (RCRA Section 4004 facilities).

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*All Figures can be found at the end of this Report.

The second step in developing an alternative classification was to consider the concentration of a hazardous waste present in a total (hazardous & non-hazardous) waste as shown in Table 10. Establishment of exempt concentrations for the various waste categories would avoid the overclassification of dilute wastes as hazardous unless the quantity of hazardous waste in the total waste exceeds the rate of generation previously defined.

This results in the coupling of only significant quantities and concentrations upon degree of hazard. This approach is similar to the one developed by the State of Washington.[1]

At 100% concentrations, the total waste is entirely hazardous waste at quantities ranging from 1 to 100,000 kg which designated the six categories (A-F). To be included in the hazardous waste management system, for example, a generator would have to generate at least 100 kg/mo of waste in Category C at a 100% concentration of 1000 kg/mo at 10% or 10,000 kg/mo or 100,000 kg/mo at 0.1% by weight to require disposal within a 3004 facility. Otherwise the waste could be disposed of adequately within a 4004 facility. Mixtures would be handled by summing the quantities within categories and then weighting among categories.

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[1] Mehlhaff, L.C., Cook, T., and Knudson, J. A Quantitative Approach to Classification of Hazardous Waste. 1979 Sanitation Industry Yearbook.

To complete the description of hazard, characteristics of effect, such as toxicity, must be coupled with those of exposure, such as migration potential, stability (persistence), and bioaccumulation (bioconcentration). This coupling can be achieved by screening tests for toxicity, bioaccumulation, and persistence. The sequence of tests is conducted partly in parallel and partly in series. The results are interpreted as follows:

1. A waste is first tested for migration potential by applying a suitable leaching test.
2. The leachate is then tested for toxicity, bioaccumulation, and persistence as appropriate.
3. If persistence and/or bioaccumulation are positive, and toxicity is also positive, the waste is hazardous.
4. If toxicity is negative, the waste is non-hazardous even if both persistence and bioaccumulation are positive.
5. A waste is not hazardous unless at least one effect (toxicity) and one exposure (bioaccumulation or persistence) test are positive (i.e., a single positive test for any of these three tests is insufficient to declare hazard).

Various hierarchies of degree of effect can be established for characteristics of effect other than toxicity that would fit into the sic categories (A-F). Examples might include ranges of acidities and flash points. Similarly, various hierarchies of degree of exposure can also be established for bioaccumulation and persistence. Examples would be ranges of partition factors and half-lives, respectively.

The influences of bioaccumulation and persistence upon toxicity are shown in Figure 2. If a toxic waste is bioaccumulative and/or persistent, the stairsteps are lowered. If a toxic waste is less bioaccumulative and/or less persistent, the stairsteps are raised. Some wastes can lose essentially all of their toxicity through bioaccumulation. Wastes in one category also could be transformed to another category. Characteristics of exposure, therefore, must be considered carefully. The ranges for these characteristics are shown only in qualitative terms in Figure 2.

3. Proposed Classification Scheme #3. This classification system is based on an integrated appraisal of the relationships between (1) the degree of hazard of a waste, (2) the characteristics and location of the disposal facility or containment method used, and (3) the potential fate of the hazardous waste upon treatment or disposal. The scheme is best illustrated by reference to Figures 3 through 10 .

4. Proposed Classification Scheme #4. This scheme proposes at least three separate classifications of hazardous wastes.

Class I. This class would consist of those wastes which are life threatening because virtually any human exposure to such wastes is considered unacceptable. Because such wastes pose a grave, constant and continuing hazard to human health and the environment during all phases of their handling and disposal, such wastes require special care in storage, handling treatment and disposal, with the means of disposal designed to provide indefinite containment and monitoring.

(a) Class I waste. (1) Definition - A solid waste is a Class I hazardous waste if a representative sample of the waste meets the characteristics specified in paragraphs (i) or (ii) below or if it is listed in paragraph (iii) below.

(i) Toxicity. The waste contains any concentration greater than [0.10% (100 ppm)] of any material with an oral mammalian LD_{50} of [5 mg/kg or less] or an aquatic (fish) LC_{50} of [1.0 mg/l or less].

(ii) Reactivity. The waste displays any of the following characteristics:

(A) Is readily capable of detonation or explosive decomposition or reaction at normal temperatures and pressures, or

(B) Is a forbidden explosive as defined in 40 CFR 173.51, a Class A explosive as defined in 49 CFR 173.53, or a Class B explosive as defined in 49 CFR 173.58.

(iii) The following wastes are classified as Class I hazardous wastes, unless it can be demonstrated, pursuant to the procedures under §250.15, that the Administrator's basis for listing the waste does not meet the criteria for listing under §250.12(b).

(2) Identification Method. Oral-rat LD_{50} protocol, based upon the NIOSH Registry of Toxic Effects of Chemical Substances (1976).

Class II. This class would consist of those wastes which pose a serious hazard to human health and the environment during some phase of their storage, handling, treatment or disposal, but which do not present the grave, constant and continuing hazard posed by Class I wastes.

Class II wastes. (1) Definition - A solid waste is a Class II hazardous if a representative sample of the waste meets any of the characteristics specified in paragraphs (i) through (iv) below.

(i) Ignitable waste. The waste displays any of the following characteristics:

(A) Is a liquid and has a closed cup flash point less than 37.8°C (100°F) determined by the method cited below or an equivalent method, and is defined as a flammable on the wick test and combustible in accordance with the British Combustibility Test, (both of which are currently under development by the ASTM Coordinating Committee on flash point and related properties), or

(B) Is not a liquid but is liable to ignite through friction, absorption or moisture, spontaneous chemical changes, retained heat from manufacturing or processing or other conditions, and when ignited burns so vigorously and persistently as to create a hazard during its management, or

(C) Is a flammable compressed gas as defined in 49 CFR 173.300(b), or is an oxidizer as defined in 49 CFR 173.51.

(ii) Corrosive waste. The waste displays any of the following characteristics:

(A) Is aqueous or a suspension and has a pH less than or equal to 2 or greater than or equal to 13 as determined by the method cited below or an equivalent method, or

(B) Corrodes steel (SAE 1020) at a rate greater than 0.250 inch per year at a test temperature of 130°F as determined by the method cited below or an equivalent method.

(iii) Reactive waste. The waste displays any of the following characteristics:

(A) Undergoes violent chemical change or forms toxic or explosive gases, vapors or fumes when exposed to catalysts, finely divided metal or common physical or chemical agents, including organic matter, or

(B) Is capable of detonation or explosive reaction but requires a strong initiating source or must be heated under confinement before initiation can take place, or

(C) Reacts violently with water or forms toxic or explosive gases, vapors or fumes when mixed with water.

(iv) Toxic waste. If, according to the methods specified in paragraph (2), the extract obtained from applying the Water Extraction Procedure (WEP) cited below to a representative sample of the waste yields a concentration of a substance which exceeds 100 times the EPA National Interim Primary Drinking Water Standard for such substance.

(2) Identification methods.

(i) Ignitable waste. (As in proposed regulations.)

(ii) Corrosive waste. (As in proposed regulations, plus addition of a method for testing a suspension.)

(iii) Reactive waste. (As in proposed regulations.)

(iv) Toxic waste. Water Extraction Procedure.

Class III. This section consists of those wastes considered to be hazardous to human health or the environment only if the wastes are not handled in a prescribed, controlled manner. Thus, the requirements for management of Class III wastes will generally only ensure that particular or certain avoidable circumstances are prevented which would otherwise result in the inclusion of such materials in the Class II category.

Class III wastes. (1) Definition - A solid waste is a Class III hazardous waste if a representative sample of the waste meets any of the criteria specified in paragraphs (i) through (iv) below.

(i) Ignitable waste. The waste displays any of the following characteristics:

(A) Is a liquid and has a closed cup flash point less than 93°C (200°F) determined by the method cited below or an equivalent method, and is defined as flammable on the wick test and combustible in accordance with the British Combustibility Test, both of which are currently under development by the ASTM Coordinating Committee on flash point and related properties and interaction with governmental agencies, or

(B) Is not a liquid but ignites when exposed to an external ignition source, and when ignited burns so vigorously and persistently as to create a hazard during its management.

(ii) Corrosive waste. The waste is aqueous or a suspension and has a pH less than or equal to 3 or greater than or equal to 12 as determined by the method cited below or an equivalent method.

(iii) Reactive waste. The waste forms toxic or explosive gases, vapors or fumes only under conditions of extreme heating in a confined space or when exposed to moderately acidic or basic conditions.

(iv) Toxic waste. If, according to the methods specified in paragraph (2), the extract obtained from applying the Acid Extraction Procedure (AEP) cited below to a representative sample of the waste yields a concentration of a substance which does not exceed 100 times the EPA National Interim Primary Drinking Water Standard for such substances.

(2) Identification Method. As proposed above Class II wastes, but substituting an acid extraction procedure for the water extraction procedure.

In addition to the above suggested scheme, the commenter recommended the following small quantity exemptions for the three classes:

Class I - 10 kg/mo

Class II - 1000 kg/mo

Class IV - 10,000 kg/mo

5. Proposed Classification Scheme #5. This scheme suggested a two-tier degree of hazard system along the following lines:

a. Primary Hazardous Waste

Toxic Waste - (1) Waste that has an acute toxicity criteria with an LD_{50} value equal to, or less than 100 mg/kg or an LC_{50} value equal to, or less than, 20 ppm.

(2) Waste characterized by significant persistence, bioaccumulation, carcinogenicity, mutagenicity, or teratogenicity.

(3) §250.13(d) at 100 times the NIPDWS.

Reactive Waste - §250.13(c)(1)(i), (1)(iii) and (1)(iv).

Infectious Waste - Wastes included in Class A or as Class 3, by the Joint Commission on Accrediting Hospitals or as Class 3, 4 or 5 as defined by CDC unless adequate provisions are taken to treat waste (Appendix VII 0 43 FR 58964).

b. Special Waste

Toxic Waste - (1) Waste that has an acute toxicity criteria with an LD_{50} value between 100 mg/kg and 2,500 mg/kg or an LC_{50} value between 20 ppm and 500 ppm.

Ignitable Waste - Waste that has the characteristics of §250.13(a)(1)(i) and (1)(ii) or an open cup flash point equal to, or less than 100°F.

Corrosive Wastes - Waste that has the characteristic of §250.13(b)(1)(i).

Reactive Waste - Waste that has the characteristic of §250.13(c)(1)(ii).

Infectious Waste - Wastes included in Class B as classified by the Joint Commission on Accrediting Hospitals or as Class 2 as defined by CDC.

6. Proposed Classification Scheme #6. This scheme suggests that at least three separate classifications of hazardous waste should be defined - "extremely hazardous", "hazardous" and "marginally hazardous" and that the Subtitle C program should be implemented in phases commencing with the extremely hazardous category. It further suggests that the Agency use a dual extraction step to develop the three-tier system. As an example, they provided the following system:

Tier I - (secure landfill) - Distilled (deionized water) as the extractant - concentrations of a contaminant exceeds the values prescribed.

Tier II - (industrial landfill) - Distilled (deionized water) as the extractant - concentrations of a contaminant not to exceed the values prescribed.

Tier III - (municipal landfill) - Distilled (deionized water) and 0.5 N acetic acid used as the extractants - concentrations of a contaminant not to exceed the values prescribed.

7. Proposed Classification Scheme #7. This scheme suggests that the Agency develop a three-class system along the conceptual lines described below:

	Exclusion Quantity	
	kg/month	(lbs/month)
Class I - Those wastes which present a serious continuing and persistent hazard to health or to the new environment and which, therefore, require special care in storage, handling, and disposal including, of course, secure landfill disposal area. This would include, for example, recognized carcinogens which have been assessed to pose unreasonable human risk at exposure levels and in situations of relevant biodegradability. This also includes highly toxic materials and highly reactive or highly corrosive wastes.	10	(22)
Class II - Those wastes which present a moderate hazard to health or to the environment, but which can be handled (except for disposal) in a normal manner using standard containers and equipment, and do not require the same degree of special care required by Class I wastes. This would include non-reactive powdered or liquid toxic materials of a persistent nature that are not recognized mutagens, but have a moderate degree of aquatic or human toxicity. Except for disposal in secure landfill areas, these wastes would not be subject to the more ressrictive controls applicable to Class I waste.	100	(220)
Class III - Those wastes which present no hazard to health or the environment when handled in a prescribed, controlled manner. This would include certain flammable materials and reactive materials which require an initiating source (such as ignition) or a combination of other materials or elements not normally encountered in the environment in order to create a hazard. This	1,000	(2,200)

> would also include special wastes where the degree of risk is sufficiently low that adequate protection is provided by technology essentially equivalent to normal sanitary landfills, but where additional management is required. Those wastes would not be subject to the restrictive controls applicable to Class I and Class II wastes, but would be subject to certain occupational health and safety regulations for handling and disposal.

8. Proposed Classification Scheme #8. This scheme suggests that the regulations be revised to include a five-year phased implementation plan. In this manner, all highly hazardous wastes, which may cause an acute impact on health and the environment, are controlled with available resources first. The scope of implementation should then be gradually increased beginning in Summer 1980, reaching full scale in five years. The specific degree of hazard system suggested is as follows:

Class A - Primary Hazardous Waste Characteristics and Listing - Applicable upon promulgation. This class includes acutely hazardous wastes which are ignitable or reactive. Toxic wastes identified by the Extraction Procedure (EP) are not included in this class.

Class B - Secondary Hazardous Waste Characteristics and Listing - Applicable two years after promulgation. This class includes corrosive wastes which are not ignitable or reactive.

Class C - Tertiary Hazardous Waste Characteristics and Listing - Applicable four years after promulgation. This class includes wastes which are determined hazardous either by chemical testing of the EP leachate or by biological testing using the leachate.

9. Proposed Classification Scheme #9. This scheme suggests that the Agency develop a degree of hazard system along the conceptual lines described below:

Class 1 - Wastes which present a constant hazard to health or the environment and cannot be safely released into the environment in any significant quantities. These wastes would require extreme care in storage, handling and transporting, and should not be landfilled unless there is no other alternative.

Class 2 - Wastes which present a constant hazard to the health or environment, but do not require extreme care in storage, handling and transporting except to avoid spills which would result in endangerment of the surface and groundwater. These wastes can be landfilled in properly designated landfills.

Class 3 - Wastes which present no hazard to health or the environment when handled in a normal controlled manner during storage, handling and transporting. These wastes can be disposed of in landfills with less stringent design criteria than those for Classes 1 and 2.

10. Proposed Classification Scheme #10. This scheme suggests that the Agency develop a degree of hazard system along the conceptual lines described below:

High Hazard Waste/Group I - Wastes which are known to present a severe, imminent danger to the environment and public health and which will require the utmost care during all stages of handling, storage and disposal are to be included in this group. An example of such materials would be highly toxic pesticides which are persistent and bioaccumulative.

Hazard Waste/Group II - Wastes which pose a possible danger to the environment or public health if disposed or indiscriminately would be included in Group II. This group would include such wastes as used organic solvents, acids and mildly toxic wastes which are not persistent.

Marginally Hazardous/Group III - Wastes for which data indicate that potential hazards are relatively low would be included in Group III. These wastes would present only a minimal hazard to health and environment and could be handled with only a minimal amount of reporting and recordkeeping. Wastes included in this group would be certain industrial sludges and the waste EPA has proposed to handle as special wastes.

11. Proposed Classification Scheme #11. This scheme suggests that the degree of care provided to a hazardous waste must be commensurate with its degree of hazard. More specifically, this scheme proposed that the following matrix rating system be utilized:

Hazardous waste facilities would be rated on the basis of containment ability rather than require all such facilities to meet given design and operation requirements. In similar fashion, waste materials would be ranked on the basis of the particular hazards, and degree of hazard posed by the waste. Thus, for example, containment facilities having a low rating would accept only waste materials having a low hazard potential and requiring low containment.

12. Proposed Classification Scheme #12. This scheme suggests that the Agency develop a five-class system defined in terms of quantity of waste and concentration of waste, with the disposal site designed for each class of waste. More specifically, the five classes suggested are:

Extremely hazardous wastes - these wastes would, if not properly handled and controlled, represent a grave risk to human health or the environment through toxicity. They would be life-threatening in nature, and would require the most secure type of disposal site.

Hazardous wastes - these would be of a toxicity range which could pose a substantial risk to health and/or the environment through improper handling, transfer or storage. However, they would not have the potential to cause an irreversible illness or death. These wastes would have to be disposed of in such a manner that it would be extremely difficult for them to get into the environment where they could contact groundwater or biological systems. They would not require the extreme care and caution that would be exercised in handling and storage of extremely hazardous waste.

Dangerous waste - these wastes would be potentially toxic but would be primarily the corrosive or flammable compounds that people occasionally must dispose of. The concept here is that they are body-threatening, rather than life-threatening, and as such might require totally different types of handling and transport procedures. Additionally, these kinds of compounds might have some potential uses and thus would be subject to a different type of storage and handling to make them available for use by others once delivered to a disposal site.

Special wastes - these wastes have some degree of hazard to health or the environment simply because of their quantity or quality, and as such can be rendered harmless by special handling, detoxification or neutralization procedures to make them nonhazardous. When these procedures are accomplished, these wastes would be disposed of in a normal, sanitary landfill or other nonhazardous waste disposal site.

Other wastes - these are wastes which may contain some small amount of hazardous substance, but because of its concentration, makeup, or potential for hazard, they can be disposed of using due care in a normal, sanitary landfill.

CHAPTER TWO

HAZARDOUS WASTE CATEGORIZATION BY STATES

2.1 INTRODUCTION

Almost all States have their own waste disposal regulations; however, only four States classify hazardous wastes in terms of hazard: California; Texas; Washington; and Rhode Island. Other States such as Maryland, Nebraska and Kentucky have very rudimentary classification schemes that do not merit serious consideration.

The relative absence of hazardous waste categorization by States in the United States can be observed also from recent surveys undertaken by the Legal Division of the Coca Cola Company.[1/] As Table 11 indicates, each of the 45 jurisdictions having statutes and/or regulations governing hazardous wastes defines that term at least broadly, e.g., as "harmful to man or the environment" (Inquiry 1).* However, the term "hazardous" waste is not uniformly or exclusively utilized. Terms such as "special" waste, "extremely hazardous" waste, and "liquid industrial" waste, are used in lieu of or in addition to the term "hazardous" waste. Thus, special attention must be given to the statutory and/or regulatory definitions in order to identify all regulated wastes.

[1/] Michael J. Gilroy. "State Regulation of Hazardous Waste Disposal". Legal Division, The Coca-Cola Company, Atlanta, Georgia, 1980.

* See Table 11.

Among the 45 jurisdictions having general definitions of "hazardous" waste or equivalent terminology, 34 specify waste characteristics such as flammability, corrosiveness and toxicity to further define hazardous waste (Inquiry 2). However, only 8 of these 34 appear to specify test protocols and test result ranges (Inquiry 3) within which wastes must fall in order to qualify as having these characteristics (e.g., a pH outside the range of 3 to 12 for a waste to qualify as corrosive).

Thirteen of the 45 jurisdictions maintain lists of specific chemical substances or families of substances which, by virtue of their inclusion on the list, qualify as "hazardous" (Inquiry 4). Nine jurisdictions list specific industry, or industrial process, waste streams which are considered "hazardous" (Inquiry 5). Finally, 5 of the 45 jurisdictions utilize volume of waste and/or specific waste characteristic test values to establish, and distinguish between, two or more classes of hazardous waste (Inquiry 6).

The following section presents descriptions of the hazardous waste categorization schemes by the four States which have such regulations.

2.2 CALIFORNIA DEGREE OF HAZARD SYSTEM

In evaluating the definition of hazardous waste as defined by the California State Department of Health, the following waste classification scheme has been developed:

Extremely Hazardous Waste - Any hazardous waste or mixture of hazardous wastes which, if human exposure should occur, may likely result in death, disabling personal injury or serious illness caused by the hazardous waste or mixture of hazardous wastes because of its quantity, concentration, or chemical characteristics.

Hazardous Waste - Any waste or combination of wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may either:

- Cause, or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness.
- Pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

Under the California system, a list of hazardous substances and wastes and a set of criteria have been developed; however, the criteria appear to be used primarily by the generator to determine whether the components of the waste occur at sufficiently high concentrations to consider the wastes hazardous.

The list of hazardous substances and wastes developed by California contains 216 extremely hazardous substances, 575 hazardous substances and 73 hazardous wastes. Anyone who generates a waste that is listed or which contains any of the listed substances will normally be classified as an extremely hazardous or hazardous waste.* If none of the waste components appears on the list, the generator must still review the literature referenced in the regulations to determine if the components are hazardous or extremely hazardous. If the literature demonstrates that any of the waste's components' values fall numerically below the criteria, that waste must be considered hazardous unless testing is conducted to reclassify the waste.

The criteria developed by the California State Department of Health for defining a hazardous or extremely hazardous waste are as follows:

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* Since the listed substances do not have appropriate concentrations associated with each substance, except in a few cases, we would conclude that the waste would be defined as hazardous if any of the hazardous substances were identified in the waste at any concentration.

	Hazardous	Extremely Hazardous
1. Toxicity		
- single oral LD_{50}	≤ 2000 mg/kg	≤ 50 mg/kg
- dermal LD_{50}	≤ 1200 mg/kg	≤ 200 mg/kg
- inhalation LC_{50}	≤ 4000 ppm (gas or vapor)	≤ 200 ppm (gas or vapor)
	≤ 10,000 mg/m^3 (dust or mist)	≤ 500 mg/m (dust or mist)
- 96-hour LC_{50}	≤ 500 mg/l	---------
- Carcinogen	Listed in the CAL-OSHA general industry safety orders Title 8, Calif. Adm. Code or suspected carcinogen, according to NIOSH	Listed in the CAL-OSHA general industry safety orders, Section 5209, Title 8, Calif. Adm. Code
- Material which, through experience of testing, has been shown to present a hazard to the public health or envi ment because:	Chronic toxicity, bioaccumulative properties, or persistence in the environment	Carcinogenicity high chronic toxicity, bioaccumulative properties, or persistent in the environment

For the remaining characteristics, a single classification scheme (i.e., pass-fail system) has been developed, as shown below.

2. Flammable

- is a liquid with a flash point ≤ 37.8°C (100°F).
- is a gas for which a mixture of 13% or less with air forms a flammable mixture at atmospheric pressure or the flammable range with air at atmospheric pressure is wider than 12% regardless of the lower limits.

- is a solid which is likely to cause fires due to friction, retained heat from processing, or which can be ignited under normal temperature conditions and, when ignited, burns so vigorously and persistently as to create a serious threat to public and safety.
- is a gas, liquid, sludge or solid which ignites spontaneously in dry or moist air (a pyrophoric material), at or below 54.3°C 9130°F), or upon exposure to wate.
- is a strong oxidizer.

3. Pressure-Generating and Reactive
   - is a Forbidden or Class A, B, or C explosive as defined in CFR, Title 49, Sections 173.51, 173.53, 173.88, and 173.1000 respectively.
   - is a water-reactive material.
   - is in the NFPA reactivity category 2, 3, or 4.
4. Corrosive
   - pH $\leq$ or $\geq$ 12, or its mixture with an equivalent weight of water produces a solution having a pH $\leq$ 2 or $\geq$ 12.
   - causes visible destruction or irreversible alterations in skin tissue (ulceration or necrosis) when tested on the skins of albino rabbits using the patch-test technique described in CFR, Title 16, Section 1500.41.

5. Irritant

- is a non-corrosive material which will induce a local inflammatory reaction using the patch test techniques described in CFR, Title 16, Section 1500.41, showing an empirical primary irritation score of 5 or more.

6. Strong Sensitizer

- if it will cause on normal, living tissue, through an allergic or photodynamic process, a hypersensitivity which becomes evident on reapplication of the same waste or component.

As indicated earlier, the criteria cited in the regulations appear to be included for the benefit of the generator if he believes his waste is not hazardous, even if a particular substance or waste is listed (i.e., the list serves as a guide for initial screening of the waste's components). Thus, if a generator questions the classification of his waste, data must then be submitted by the generator (i.e., calculated toxicity of the waste and/or whole animal studies on the hazardousness of his waste. After the data have been compiled and submitted to the California State Department of Health, a decision would be made whether or not to reclassify the waste.

2.2.1 California Procedures for Evaluating the Hazardous and Extremely Hazardous Properties of Wastes

In the evaluation of the hazardous and extremely hazardous properties of a waste, the following steps are conducted in the indicated sequence within a given category (i.e., toxicity, flammability, except as noted. Those hazard categories to be tested by the generator will depend on the category of hazard associated with the waste components. Thus, it may not be necessary to test for all six hazard categories. In addition, evaluation of a waste may be stopped when any step indicates the waste is hazardous or extremely hazardous.

Toxicity

Step 1: Determine if the waste contains a toxic substance or extremely toxic substance (see California hazardous and extremely hazardous waste list). If it does, it is designated toxic and extremely toxic unless steps 2 - 4 are carried out. If it does not, the waste is designated nontoxic or not extremely toxic.

Step 2: Determine if the waste (or its extract when applicable) contains a carcinogenic, persistent, or bioaccumulative substance in excess of the designated threshold level concentrations as indicated in the regulations. If it does, it is designated toxic or extremely toxic, and none of the following steps need to be carried out.

Steps 3 and 4 are carried out. (Step 4 may be done before Step 3.)

Step 3: Toxic Wastes - Determine if the waste is acutely toxic to fish as follows:

(a) Determine if the waste has a 96-hour LC_{50} for fathead minnows (pimephales promelas) of 500 mg/l or less. If it does, the waste is designated toxic, and none of the following steps need to be carried out.

(b) If the waste is a solid, sludge, tar, or slurry which is not entirely soluble in water at 500 mg/l and if Step 3a shows a 96-hour $LC_{50} \geq$ 500 mg/l for a suspension of the waste in water, determine if the extract from the waste produces a 96-hour LC_{50} of 6 m/l or less for fathead minnows.

Extremely Toxic Wastes - Determine if the waste should be tested for extreme toxicity to mammals as follows:

(a) Oral and Dermal Toxicity - Determine if the calculated oral and dermal LD_{50}'s are less than or equal to 50 mg/kg and 200 mg/kg respectively for wastes using the following equation.

$$\text{Calculated } LD_{50} = \frac{10}{\sum_{X=1}^{n} \frac{\%A}{LD_{50}A_x}}$$

where: $LD_{50}A_x$ = the oral or dermal LD_{50}'s of the pure toxic components; $\%A_x$ = present concentrations by weight of the toxic component in the waste.

(Only substance with reported oral LD_{50}'s $\leq$ 50 mg/kg or dermal LD_{50}'s $\leq$ 200 mg/kg need be considered in these calculations). If the calculated LD_{50}'s are numerically less than or equal to the above stated limits, the corresponding oral or dermal toxicity test in Step 4 should be carried out; if it is not carried out, the waste is designated extremely toxic and no further evaluation is required. If the calculated LD_{50}'s are numerically greater than the acceptable criteria limits, Step 3b is carried out.

(b) Inhalation Toxicity -

i. Vapor Hazards - If the waste contains one or more volatile, toxic substances with an inhalation $LC_{50} \leq$ 200 ppm and vapor pressure $\geq$ 1 mm Hg at 20°C, determine if the waste has the potential of generating a hazardous vapor mixture by calculating the vapor hazard index (VHI) as follows:

$$\text{VHI} = 6{,}600 \sum_{X=1}^{n} \frac{(P^\circ_{Ax})\ (\%A_x)}{(M_{Ax})\ (T_{Ax})}$$

where: - $P^\circ A_x$ = the vapor pressures 20-35°C of the pure volatile, toxic substances (expressed in units of mm of Hg) $\%A_x$,

- $\%A_x$ = present concentration by weight of the toxic components in the waste,
- M_{Ax} = molecular weight of the toxic components,
- T_{Ax} = toxicities in ppm by volume in air.

If the VHI is greater than or equal to one, Step 4 should be carried out. If Step 4 is not done, the waste is designated extremely toxic, and no further testing is required. If the VHI is less than one, Step 3(b)(kk) is carried out.

ii. Dust or mist hazard - If the waste consists of a liquid, soot, sludge[1] slurry[1] or friable solid, determine if the waste has a calculated inhalation LC_{50} less than or equal to 500 mg/m^3 using the following equation:

$$\text{Calculated } LC_{50}\ (mg/m^3) = \frac{10}{\sum_{X=1}^{n} \frac{\%A_x}{T_{Ax}}}$$

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[1] Applies to any slurry or sludge which, when dried, produces a friable solid.

where: - $\%A_x$ = percent concentrations by weight of the toxic components in the waste,

- TA_x = the inhalation toxicities expressed in mg of substance per cubic meter of air (LC_{50}, LC_{Lo}, or 100 x TLV).

(NOTE: $\text{mg/m}^3 = \dfrac{\text{ppm X molecular weight}}{24.5}$

Only substances with reported LC_{50}'s $\leq$ 500 mg/m^3 need be considered in calculation an LC_{50} for the waste. If the calculated LC_{50} is less than or equal to 500 mg/m^3, Step 4 should be carried out. If Step 4 is not done, the waste is designated toxic, and no further evaluation is necessary.

ic Wastes - Determine if the waste should be tested
toxicity to mammals using the equations listed
Step 3 of the extremely hazardous waste evaluation
eme. Only toxicity data on the toxic components
the waste shall be used. If the calculated toxici-
s are numerically less than any of the following
its, the appropriate tests in Step 5 should be
ried out:

Oral: $LD_{50} \leq$ 2,000 mg/kg

Dermal: $LD_{50} \leq$ 1,200 mg/kg

Inhalation:

(i) Vapor: VHI ≥ 1 (where only components with a vapor pressure ≥ 1 mm Hg at 20°C and $LC_{50} \leq 4{,}000$ ppm are used in the calculation).

(ii) mist or dust: $LC_{50} \leq 10{,}000$ mg/m^3

If step 5 is not done, the waste is designated toxic. If all calculated LD_{50}'s and LC_{50}'s exceed these limits and the VHI is less than one and the waste passes Step 2, it is designated not toxic.

Extremely Toxic Wastes - Determine if the waste is extremely toxic to mammals. If any of the calculations in Step 3 indicate a potential extreme oral, dermal, or inhalation toxicity hazard from the waste, the corresponding animal toxicity testing shall be conducted. If the measured oral or dermal LD_{50} or inhalation LC_{50} is equal to or less than the extreme toxicity criteria, the waste is designated extremely toxic (extremely hazardous), and no further testing is required. If none of the measured toxicity limits is reached, the waste is not extremely toxic (not extremely hazardous).

Step 5: Toxic Wastes - Determine if the waste is acutely toxic to mammals. If any of the calculations in Step 4 indicated a potential oral, dermal, or inhalation hazard from the waste, the corresponding animal toxicity testing should be conducted. If the oral or dermal LD_{50} or inhalation LC_{50} equals or falls below the limits listed in the toxicity criteria, the waste is designated toxic, and no further testing is necessary. If none of the measured toxicity parameters are less than or equal to their respective lower limits and the waste has passed Steps 2 and 3, the waste is designated non-toxic.

Flammability

Step 1: Determine if the waste contains a flammable substance. If it does, the waste is designated flammable unless the following step is carried out. If it does not, the waste is designated nonflammable.

Step 2: Determine if the waste itself conforms to any of the flammability criteria or definitions. If it does, it is designated flammable, and no further testing is necessary.

Pressure-Generating and Reactive

Step 1: Determine if the waste contains a pressure-generating or reactive substance. If it does, the waste is designated pressure-generating or reactive unless the following steps are carried out. If it does not, the waste is designated not pressure-generating or not reactive.

Ste Determine if the waste conforms to any of the criteria or definitions. If it does, it is designated pressure-generating or reactive, and no further testing is necessary.

Corrty/Irritation

Step Determine if the waste contains a corrosive or irritating substance. If it does, the waste is designated corrosive and irritant, respectively, unless the following steps are carried out. If it does not, the waste is designated noncorrosive and nonirritant.

Step (a) If the waste is an aqueous-based solution or mixture, determine if its pH is ≤ 2 or ≥ 12.

(b) If the waste is not an aqueous-based solution or mixture, determine if a mixture of the waste in an equal weight of distilled water has a pH ≤ 2 or ≥ 12.

If either Tests 2a or 2b indicate a pH value ≤ 2 or ≥ 12, the waste is designated corrosive, and no further testing is necessary. If they do not, Test 3 is carried out.

Step Conduct a test with the waste on the skins of albino rabbits using the patch test technique described in CFR, Title 15, 1500.41. If the waste causes on skin tissue visible destruction or irreversible alterations (ulceration or necrosis), the waste is corrosive. If it does not, the waste is noncorrosive. If it causes a local flammatory skin reaction showing a empirical primary irritation score of 5 or more, the waste is an irritant. If it does not, the waste is a nonirritant.

Strong Sensitizer

Step 1: Determine if the waste contains a strong sensitizing substance. If it does, the waste is designated a strong sensitizer unless Step 2 is carried out. If it does not, the waste is designated nonsensitizing.

Step 2: Determine by testing if the waste conforms to the definition of a strong sensitizer. If it does, it is designated a strong sensitizer, and no further testing is required.

2.3 TEXAS DEGREE OF HAZARD SYSTEM

The definition of hazardous waste established by the Texas Department of Water Resources includes the following waste classification scheme which is based on the possible adverse impact that land disposal of certain types or classes of industrial solid waste might have:

Class I - Any industrial solid waste or mixture of wastes, which because of its concentration or physical or chemical characteristics is toxic, corrosive, flammable, a strong sensitizer or irritant, generates sudden pressure by decomposition, heat or other means and may pose a substantial present or potential danger to human health or the environment when improperly treated, stored, transported, disposed, or otherwise managed, including hazardous wastes identified by the administrator of the U.S. DPA pursuant to the Federal Solid Waste Disposal Act.

Class II - Any industrial solid waste or combination of industrial solid wastes which cannot be described as Class I or Class III as defined in the regulation.

Class III - Essentially inert and essentially insoluble industrial solid waste, usually including materials such as rock, brick, glass, dirt, certain plastics, rubber, etc. that are not readily decomposable.

In the Texas classification system, both a list of hazardous substances and a set of criteria have been developed. However, it would appear from the regulations that the criteria are used primarily by the generator to reclassify his waste rather than classify the waste.

The list of hazardous substances developed by Texas contains approximately 300 toxic substances, 100 corrosives or irritants, 250 flammable materials, 10 strong sensitizers and 40 pressure-generating materials. Seventy wastes are included on the list. Anyone who generates a waste which contains any of the listed substances will normally be classified as Class I wastes. Since the listed substances in most cases do not have appropriate concentrations associated with each substance, one would conclude that a waste would be defined as hazardous if any of the listed substances were identified in the waste at any concentration. It is not clear how the Texas Department of Water Resources developed the list of hazardous substances. The initial classification of the waste is made by the State on the readily available information with a conservation comparison to the criteria (i.e., a sample of the waste is submitted by the generator to the Texas Department of Water Resources for analysis).

The criteria which have been developed by the Texas Department of Water Resources in defining a hazardous waste are as follows:

	Class I	Class II	Class III
1. A calculated Hazard Index	≤ 50	> 50	> 50
2. A calculated or actually determined LD$_{50}$ (by Finney's mathematical model for joint additive toxicity)	≤ 500 mg/kg	> 500 mg/kg	> 500 mg/kg
3. pH	< 2.5 and > 12	2.5 to 12	2.5 to 12
4. A corrosion rate on steel (SAE 1020) at a test temperature of 130°F as determined by NACE	> 0.25 in/yr	< 0.25 in/yr	< 0.25 in/yr
5. A flash point determined by a Pensky-Martens Closed Cup Tester, using ASTM Std. D-93-73	≤ 140°F	> 140°F	> 140°F

(a) A waste may normally be reclassified to Class III if the waste could be reclassified Class II under the specific criteria limits outlined above and if the waste's liquid fraction, or the leachate obtained with distilled water from a dry solid waste, contains no concentration of any component in excess of the limits set by the U.S. EPA or the U.S. Public Health Service for that component in drinking water.

As indicated earlier, the criteria cited in the regulations appear to be included for the benefit of the generators as reclassification criteria limits, i.e., to reclassify a waste from Class I to Class II or Class III. If the generator believes

ot hazardous (i.e., questions the initial classi-
e waste), then data must be submitted on the
d above. This includes:

description of the process or processes from
ich the waste was generated.

qualitative and quantitative analysis of the
ste material. Such analyses should only be
rformed for those components that could reason-
ly be expected to be present in the waste due to
e process or processes from the waste which was
nerated.

qualitative and quantitative analysis of the
quid fraction of a waste or of the leachate.

ammability of the liquid fraction of the waste
d/or leachate.

rrosivity of the liquid fraction of the waste
d/or leachate.

oundwater quality in the vicinity of the pro-
sed disposal site (necessary only in the case of
Class I to Class III reclassification).

listed above has been compiled, it would be
specific criteria listed above to determine
the waste may be reclassified.

2.3.1 Texas Hazard Index

The Hazard Index (HI) of a material is a parameter developed by the Texas Department of Water Resources by which a material's possible environmental impact from improper disposal may be calculated based on the material's solubility and toxicity. The parameter HI may be defined by either of the following equations:

$$(1)\quad HI = \frac{50}{\frac{S_w}{Tox_w}} \quad \text{or} \quad (2)\quad HI = \frac{50}{{}_{1}^{N} \; \frac{C_i}{Tox_i}}$$

where S_w = the solubility of the waste in mg/l

Tox_w = the toxicity of the leachate or liquid fraction waste as Oral LD_{50} in mg/kg

C_i = the concentration of component i in a liquid fraction of the waste, or the leachate from a dry solid waste

Tox_i = the toxicity of component i expressed as Oral LD_{50}, Oral LDL_o or TDL_o

Oral LD_{50} = a calculated dose of a chemical substances which is expected to cause the death of 50% of an entire population of an experimental animal species, as determined by exposure to the substance by an oral route of a significant number of that population.

Oral LDL_o = the lowest dose of a substance other than the LD_{50} introduced by an oral route over any given period of time and reported to have caused death in many or the lowest single dose introduced orally in one or more divided portions and reported to have caused death in animals.

Oral TDL_o = the lowest dose of a substance, introduced by an oral route over any given period of time and reported to produce any toxic effect in man or to produce carcinogenic, teratogenic, mutagenic or neoplastigenic effects in humans or animals.

2.4 WASHINGTON DEGREE OF HAZARD SYSTEM

The degree of hazard system for toxic wastes used by Washington State is based on a categorization scheme utilizing both aquatic toxicity (LC_{50}) and oral toxicity (LD_{50}). This basic scheme is as follows:

- Category A - any substance which in its pure form has an oral $LD_{50} < 5$ mg/kg, or any substance which in its pure form has an aquatic $LD_{50} < 1$ ppm.
- Category B - any substance which in its pure form has an oral LD_{50} of between 5 to 50 mg/kg, or any substance which in its pure form has an aquatic LC_{50} of between 1 and 10 ppm.
- Category C - any substance which in its pure form has an oral LD_{50} of between 50 to 500 mg/kg, or any substance which in its pure form has an aquatic LC_{50} of between 10 to 100 ppm.
- Category D - any substance which in its pure form has an oral LD_{50} of between 500 mg/kg to 5 g/kg, or any substance which in its pure form has an aquatic LC_{50} of between 100 to 1000 ppm.

(Substances with different oral LD_{50}'s and LC_{50}'s will be classified in the more restrictive category.)

Based on this scheme, the Washington Department of Ecology has developed a two-tier degree of hazard system for toxic wastes which includes extremely hazardous wastes and dangerous wastes. The extremely hazardous category was to be distinguished from the dangerous category because of its persistence, bioconcentration of genetic effects, and extreme toxicity, or because such quantities present an extreme hazard to man or wildlife. The specific criteria developed by the Department of Ecology are as follows:

(a) Dangerous Wastes - A toxic dangerous waste is any waste greater than 50 kg (100 lb.) in weight and whose oral $LD_{50} < 5$ g/kg and whose aquatic $LC_{50} < 1000$ ppm and includes wastes with:

  - greater than 0.01% Category A substances,
  - greater than 0.1% Category B substances,
  - greater than 1% Category C substances, or
  - greater than 10% Category D substances.

  In addition, wastes containing "etiologic agents" are toxic dangerous wastes.[1]

(b) Extremely Hazardous Waste - An extremely hazardous waste is any waste which is:

  - Hazardous due to Toxicity to Man and Wildlife - Any waste whose oral aquatic LD_{50} 50 mg/kg or any waste whose aquatic LC_{50} 10 ppm and includes wastes with:

1/ Etiologic Agent - A viable microorganism or its toxin which causes, or may cause, human disease and is limited to those agents listed in 42 CFR 72.25(c) of the regulations of the Department of Health, Education and Welfare.

- greater than 1% of Category A substances and 500 g (1 lb.) of Category A substances.
- greater than 10% of Category B substances and 5 kg (10 lbs) of Category B substances.

Any waste having category A, B and C substances shall be extremely hazardous when:

$$\% A + \frac{\% B}{10} \;\&\; \frac{\% C}{100} > 1\%$$

$$\text{grams A} + \frac{\text{grams B}}{10} \;\&\; \frac{\text{grams C}}{100} > 500 \text{ grams}$$

or

$$\text{pounds A} + \frac{\text{pounds B}}{10} \;\&\; \frac{\text{pounds C}}{100} > 1 \text{ lb.}$$

- Hazardous due to Quantity - Any waste whose oral $LD_{50} < 500$ mg/kg or any waste whose aquatic $LC_{50} < 100$ ppm when the quantity of such waste exceeds 50 kg (100 lbs.) and includes wastes with:
  - greater than 0.1% of Category A substances and when the waste contains more than 500 grams (1 lb.) of Category A substances,
  - greater than 0.1% of Category B substances and when the waste contains more than 5 kg (10 lbs) of Category C substances.

Any waste having category A, B and C substances shall be extremely hazardous when:

$$\% A + \frac{\% B}{10} \ \& \ \frac{\% C}{100} > 0.1\%$$

and

$$\text{grams A} \ \& \ \frac{\text{grams B}}{10} \ \& \ \frac{\text{grams C}}{100} > 500 \text{ grams}$$

$$\text{pounds A} \ \& \ \frac{\text{pounds B}}{10} \ \& \ \frac{\text{pounds C}}{100} > 1 \text{ lb.}$$

- Hazardous due to Persistence and Potential Hazard - any waste whose quantity is greater than 50 kg (100 lb) and whose concentration of soluble heavy metals, halogenated hydrocarbons, or polycyclic, aromatic hydrocarbons exceeds 1%.

dition to the above degree of hazard scheme for , the Department of Ecology has defined any waste 50 kg (100 lb) in weight and which is corrosive, r flammable as physically dangerous wastes (i.e., hazard for these particular types of wastes). The OE has defined these terms as follows:

Corrosive - Substances which, when mixed with an equal weight of water, yield a solution with a pH greater than 11 or less than 3.

- Explosive - Substances capable of producing an explosion, which are not regulated by Chapter 296-52 WAC (Washington Administrative Code) and which:
    - Evolve heat or gas when heated to 40°C (100°F), or
    - Evolve gas or heat when mixed with at 40°C (1-0°F), or
    - Contain oxidizers, that is, substances that yield oxygen readily.
- Flammable - Substances which have a flash point at or below 40°C (100°F), as determined by the Tagliabue open cup tester, or other suitable methods.

2.5 RHODE ISLAND DEGREE OF HAZARD SYSTEM

The State of Rhode Island has developed a degree of hazard system along the following lines:

2.5.1 Toxic Wastes

"Type 1A - Highly Toxic Waste" shall mean a waste which meets any of the following criteria:

a. The elutriate obtained by applying the Toxicant Extraction Procedure to a representative sample of the waste has any of the following properties as calculated using a recognized reference or where a recognized reference is not available as actually measured:

1. An acute oral LD_{50} in the rate of 0 to 50 mg/kg of body weight determined when tested according to an approved protocol; or
2. An acute LC_{50} in bluegills less than 0.1 ppm, when tested according to an approved protocol; or
3. A quantitative analysis of the elutriate reveals that it contains a concentration of any substance for which an EPA Primary Drinking Water Standard has been established, equal to 10 times greater than that standard; or

b. An octanol/water partition coefficient (P) with log P greater than 3.0, according to an approved protocol; or

c. Contains as a component any chemical which has been designated as a carcinogen, a suspect carcinogen, mutagen, or teratogen in regulatory rule-making by any of the federal agencies (OSHA, EPA, FDA, or CPSC) at or above the levels designated by the agency; or

d. A quantitative analysis of a liquid waste reveals that it contains a substance which in the concentration present in the waste causes the waste to have a calculated rate LD_{50} of 50 mg/kg or less, as listed in an approved reference source.

"Type 1B - Moderately Toxic Waste" shall mean a waste which meets one of the following criteria:

a. A elutriate obtained by applying the Toxicant Extraction Procedure to a representative sample of the waste has any of the following properties as measured and/or calculated from an approved reference source.

   1. An acute oral LD_{50} in the rate greater than 50 but less than 500 mg/kg of body weight as determined when tested according to an approved protocol;

   2. An acute LC_{50} in bluegills of less than 1 ppm but greater than 0.1 ppm when tested according to an approved protocol.

b. A quantitative analysis of the waste reveals that it contains a substance which in the concentration present in waste causes the waste to have a calculated LD_{50} of greater than 50 mg/kg but less than 500 mg/kg of body weight as listed in an approved reference source.

"Type 1C - Slightly Toxic Waste" - shall mean a waste which means one of the following criteria:

a. The elutriate obtained by applying the Toxicant Extraction Procedure to a representative sample of the waste has any of the following properties as measured and/or calculated from an approved reference source:

   1. An acute oral LD_{50} in the rat greater than 500 but less than 5,000 mg/kg body weight as determined when tested according to an approved protocol; or

2. An acute LC_{50} in bluegills greater than 1 ppm but less than 10 ppm when tested according to an approved protocol; or

b. A quantitative analysis of the waste reveals that it contains a substance which in the concentration present in the waste causesthe waste to have a calculated rat LD_{50} of greater than 500 but less than 5,000 mg/kg body weight as listed in an approved reference source.

2.5.2 Reactive Wastes

"Type 2A - Highly Reactive Waste" shall mean a waste which in itself is readily capable of initiating a detonation, or of explosive decomposition, reaction at normal temperatures and pressures, or which reacts explosively with water.

"Type 2B - Moderately Reactive Waste" shall mean a waste which in itself is capable of initiating a detonation or explosive reaction but requires a strong initiating source, or which must be heated under confinement before initiation, or which may react violently with water or oxidizable materials or which may form potentially explosive mixtures with water or oxidizable materials, or which may generate toxic fumes, such as cyanide and sulfide bearing wastes.

"Type 2C - Slightly Reactive Waste" shall mean a waste which in itself or when mixed with water is normally unstable or readily undergoes chemical change, but does not detonate or cause explosive reactions.

2.5.3 Flammable Wastes

"Type 3A - Highly Flammable Waste" shall mean:

a. Any liquid or gaseous material which is a liquid while under pressure, having a flash point below 73°F and a boiling point less than 100°F.

b. Any compressed gas or mixture for which a mixture of 13% or less (by volume) with air forms a flammable mixture, or the flammable range with air is wider than 12% regardless of the lower limit.

"Type 3B - Moderately Flammable Waste" shall mean:

a. A liquid having a flash point less than 73°F and a boiling point at or above 100°F, and those having a flash point at or above 73°F and a boiling point less than 100°F, or a liquid that ignites spontaneously in dry or moist air at or below 130°F.

B. Any compressed flammable gas or mixture having in the container an absolute pressure exceeding 40 psi 70°F, or regardless of the pressure at 70°F, having an absolute pressure exceeding 104 psi at 130°F, or any liquid flammable materials having a vapor pressure exceeding 40 psi absolute at 100°F.

"Type 3C - Slightly Flammable Waste" shall mean:

a. Liquids having a flash point above 100°F, but not exceeding 200°F.

b. Solids and semi-solids which readily give off flammable vapors below 100°F.

2.5.4 Corrosive Wastes

"Type 4 - Corrosive Waste" shall mean a waste which has any of the following properties:

a. Any aqueous waste having a pH less than or equal to 3.0, or greater than or equal to 12.0 as determined with a pH meter using the protocol specified in the "Manual or Methods for Chemical Analysis of Water and Wastes", EPA-625-16-74 003.

b. A non-aqueous waste, when mixed 50% of weight with distilled water, yields an aqueous portion with a pH less than or equal to 3.0, or greater than or equal to 12.0 as measured with a pH meter using the protocol specified in the "manual of Methods for Chemical Analysis of Water and Wastes", EPA-625-16-74 003.

c. A gaseous material such that a 2 molar aqueous solution yields a pH less than or equal to 3.0, or greater than or equal to 12.0 as measured with a pH meter using the protocol specified in the "Manual of Methods for Chemical Analysis of Water and Wastes", EPA-625-16-74 003.

d. A corrosion rate greater than 0.250 inch per year on steel (SAE 1020) at a test temperature of 130°C as determined by NACE standard TM-01-69.

2.5.5 Infectious Wastes

"Type 5 - Infectious Waste" shall mean a substance that contains micro-organisms or helminths of CDC Classes 2 through 5 of the Etiologic Agents listed in this regulation, if generated in quantities over 200 kg/month (440 pounds).

2.5.6 Radioactive Wastes

"Type 6 - Radioactive Waste" shall mean low level radioactive wastes including all solid, liquid and gaseous waste that exceed the maximum permissible concentrations for discharge to unrestricted areas as listed in Part A, Appendix A, Table II, columns 1 and 2 of 10 CFR 20, except that defined as high level solid, liquid or gaseous radioactive waste. High level solid, liquid and gaseous radioactive waste. High level solid, liquid and gaseous radioactive waste includes, but is not restricted to the solid, liquid and gaseous wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and concentrated wastes from subsequent extraction cycles, or equivalent, and concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing of irradiated reactor fuel.

2.5.7 Irritating Wastes

"Type 7A - Highly Irritating Waste" shall mean a waste which has a mean Draize score of 6.6 to 8.0 when tested by an approved protocol; or which causes visible destruction or irreversible alterations in human skin tissue at the site of contact as determined by the methods of 49 CFR 173.240, Appendix D.

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C_i = The concentration of a substance in a sample of the liquid waste or in the elutriate obtained by applying the Toxicant Extraction Procedure to other wastes.

$(LD_{50})i$ = Oral, rat LD_{50} listed in a recognized source.

2.6 EXAMPLES FROM OTHER STATES

As already noted only four states have rigorous hazardous waste classification schemes and these have been discussed in the previous sections of this chapter. This section presents brief examples of hazardous waste classification as used by states of Maryland, Nebraska and Kentucky. The principal purpose for this is to provide examples of the very limited hazardous wastes classification schemes as used by most states in the United States.

2.6.1 Maryland Degree of Hazard System

The Maryland Water Resources Administration has developed the following waste classification scheme:

Class I - included hazardous substances for which the Administration determines that sufficient documentation is available to indicate that improper disposal of these substances presents a grave risk to human health or the environment. The Administration may require pretreatment of these substances to lessen or eliminate their hazardous properties.

Class II - includes hazardous substances for which the Administration determines that information is available to indicate that improper disposal of the substances poses a major risk to human health or the environment.

Class III - includes hazardous substances which the Administration determines may pose a substantial threat to human health or the environment under certain conditions.

As is indicated, Maryland differentiates between the three classes of hazardous waste by the quantity of information available on the waste and the degree of risk to human health or the environment posed by the waste.

In addition to the narrative description, a list of specific chemicals and a set of general criteria for identifying designated hazardous substances are included in Maryland's regulations. The list of hazardous substances developed by the State contains approximately 35 Class I hazardous substances, approximately 25 Class II hazardous substances, and an undetermined number of Class III hazardous substances (see Table 5). Also, a hazardous substance may be identified as a Class I, II or III hazardous substance if:

- it is included in 40 CFR Part 116;
- it is designated as a toxic pollutant or hazardous substance under §307(a)(1) or §311(b)(2)(A) respectively of the Clean Water Act;
- it is a chemical substance for which a maximum contaminant level has been established under the Safe Drinking Water Act;
- it is a chemical substance designated under §6 of the Federal Toxic Substances Control Act; or

- it is listed as a hazardous substance under Subtitle C of the Resource Conservation and Recovery Act of 1976.

The criteria for identifying hazardous substances or for reclassifying the designation of a hazardous substance are as follows:

- toxic effects such as concogenocity, teratogenicity, mutagenicity, and lethality;
- flammability or explosion potential;
- acid or caustic nature of the substance;
- reactive capability of the substance and nature of derivative products or by-products;
- bioconcentrative characteristics;
- persistence in the environment;
- mobility of the substance;
- synergistic and antagonistic effects; or
- other factors as deemed appropriate by the Administration.

As noted, the criteria do not have any specific limits associated with them, but will be used by the Maryland Water Resources Administration as a tool to assist them in identifying Class I, II, or III hazardous substances (i.e., classification of the waste is based on what the Administrator determines).

2.6.2 Nebraska

According to the State of Nebraska Department of Environmental Control, the criteria of hazardous waste can include both physical form, quantity of hazardous wastes and hazardous characteristics. The physical form according to the Department of Environmental Control of the State of Nebraska is divided into solid, liquid, semi-solid, sludge, or contains gas. Hazardous characteristics are used by the Department of Environmental Control to describe the properties of material which make "it a threat to public health, welfare, safety or the environment." The descriptions used are as follows:

Toxicity
Oxidizing power
Irritation
Strong sensitizer
Bio-concentration
Heat generation
Poisons characteristics

Furthermore the Department of Environmental Control recognizes the following categories of hazardous wastes:

Organics
Inorganics
Organics with heavy metals
Inorganics with heavy metals

Note that the State of Nebraska Department of Environmental Control does not differentiate among categories of hazardous wastes in terms of the degree of hazard. (Table 12)

2.6.3 Kentucky

The State of Kentucky has described classification of extremely hazardous waste as follows:

> SECTION 8. DETERMINATION OF EXTREMELY HAZARDOUS WASTE
>
> A waste will be considered extremely hazardous if it contains any organic substance which has a calculated human LD50 of less than 50 mg/kg at a concentration in mg/L greater than or equal to 0.35 times its LD50 expressed in units of mg/kg. 1/

1/ Hazardous Waste Guidelines, Division of Hazardous Material and Waste Management, Department of Natural Resources and Environmental Protection, 1121 Louisville Road, Frankfort, Kentucky, November 1979.

CHAPTER THREE

HAZARDOUS WASTE CATEGORIZATION BY VARIOUS NON-GOVERNMENT ORGANIZATIONS IN THE UNITED STATES

This chapter presents discussion of hazardous waste categorization schemes by several non-government organizations in the United States.

3.1 TRW SYSTEMS GROUP[1/] RECOMMENDED METHODS OF REDUCTION NEUTRALIZATION, RECOVERY, OR DISPOSAL OF HAZARDOUS WASTE

The TRW report initially classifies waste stream constituents into three categories: Category 1, candidates for National Disposal Sites; Category 2, candidates for Industrial Disposal; and Category 3, candidates for Municipal Disposal. Classification of waste stream constituents requires consideration of both the hazards associated with the constituents an the evaluation of the adequacy of the currently practiced treatment and disposal practices. The criteria used in classifying waste stream constituents are as follows:

> Category 1: Materials are very difficult to handle, have Threshold Values less than or equal to 1 ppm, and/or are very highly flammable, and/or are currently regulated or considered for regulation by the Environmental Protection Agency.
>
> Category 2: Material can be handled by normal industrial procedures, can be incinerated with proper scrubbing equipment, buried without treatment in a Class 1 landfill, or broken down by biological processes as utilized by industry.

[1/] Ottinger, R.S., et al. (TRW Systems Group) Recommended methods of reduction, neutralization, recovery or disposal of hazardous waste. U.S. Environmental Protection Agency, Aug. 1973. 16 v. (Distributed by National Technical Information Service, Springfield, Va., as PB-224 579).

Category 3: Materials are relatively easy to handle, can be incinerated without scrubbing, buried in a Class 2 landfill, or treated by municipal sewage treatment processes.

The landfill classifications are taken from the California State Department of Public Health, the Department of Water Resources. Class 1 landfills are those sites located over non-waster bearing sediments or with only unusable group water underlying them. The site location must provide complete protection from flooding, surface runoff or drainage, and waste materials and all internal drainage must be restricted to the site. Class 2 landfills are sites underlain by usable ground water, and they may be located adjacent to streams. A distance of separation must be maintained between the bottom of the fill and the water table. Surface water must be restricted from the site, to preclude water contact with the wastes.

A Profile Report is prepared for each of the waste stream constituents studied. The first three sections of the report present information characterizing the waste stream constituents. An introductory section contains such information as manufacturing techniques, production rates, use patterns, and types, quantities, sources, and distribution of wastes containing the constituent. Pertinent physical/chemical properties of the material are also summarized here. A toxicology section generally documents recommended Threshold Limit Values (TLV) for man, the TLm for fish, acute oral and dermal LD_{50} values for various forms of animal life, plant reactions following exposure, and exposure symptoms in man. (The TLV is that concentration of an airborne constituent to which workers may be exposed repeatedly, day after day, without adverse effect.) A section describing other than toxicological (or radiation) hazards completed the characterization of the constituent. The types of hazards included in this section are flammability, explosiveness, corrosiveness, and detectability.

The next section of the Profile Report discusses the overall hazard associated with the waste management sequence between waste constituent generation and waste disposal. Adequate waste management is defined in terms of maximum acceptable levels of occurrence in air, water, and soil, based mainly but not solely on the toxicological effects of the waste constituent. Maximum acceptable levels of occurrence are designated as Recommended Provisional Limits.

The Recommended Provisional Limits in air are equal in value to one-hundredth of the established TLV. For constituents without an established TLV, that of a structurally related compound is used. The Recommended Provisional Limits in water and soil are equal in value, based on the worst case assumption that contaminated soil is completely non-retentive, and that the contaminant eventually percolates to the ground water table, and eventually becomes potable water. These concentration limits are equal in value to current drinking water standards, or one-hudredth of the lowest reported drinking water study level in cases where no drinking water standard exists.

In the absence of drinking water standards or study limit values, provisional limits are calculated on the basis of the Stokinger and Woodward method. By this method, limiting concentrations for water are based on the TLV's of hazardous materials. The assumption underlying this method is that the noninjurious amount taken into the blood stream by inhalation is equal to that which can be taken orally in water. When this calculation is applied and no established TLV exists, then the TLV of a structurally related compound is used.

TRW reports that in a reasonable number of instances drinking water standards are roughly approximated by using a 100-fold safety factor to the lowest drinking water study levels or to the limits obtained by the Stokinger and Woodward method. Limiting concentrations for organic compounds present the greatest difficulty, however. The Stokinger and Woodward limits often exceed the minimum concentration producing detrimental effects in fish. Also, the calculated value may greatly exceed known odor and taste thresholds for man. In the absence of additional toxicity or annoyance data, a 100-fold safety factor is applied to the calculated values to give the provisional limiting concentrations.

As an additional safety feature, these limiting concentrations are compared with "safe" concentrations for fish. The rule-of-thumb method for determining the "safe" concentration, as reported by Sprague, is to multiply the 48-hour TLm by one-tenth. Generally, recommendations for maximum levels are 0.1 to 0.05 toxic units for non-persistent pollutants, and 0.1 to

0.01 toxic units for persistent chemicals and pesticides, mostly of the lower figure. In the absence of TLV's for man, fish limits serve as tentative limiting concentrations.

The ratio of the five-day biological oxygen demand to the ultimate oxygen demand is used as a measure of persistence of a substance in the environment. Any substance with a value less than 20 percent is considered to be persistent. Available data on the accumulation of toxic substances in the ecologic cycle is also used in evaluating the persistence of a substance.

The last two sections of the Profile Report are concerned with evaluation of current waste management practices and applicability to the concept of National Disposal Sites. Current waste management practices are evaluated in regards to disposal disposal efficiency, operational safety, and environmental impact. The final section recommends the general class of waste treatment required by the subject waste stream constituents. The criteria used for the identification of candidates for National Disposal Sites are listed in Table 13. This set of criteria reflects: (1) the abundance of the material present as wastes; (2) the degree of hazard associated with the waste material, and (3) the complexity of treatment that is required in the disposal/recovery of the waste material. Unfortunately, the criteria do not define "sizeable quantities," "highly toxic," or "toxic."

3.2 NATIONAL ACADEMY OF SCIENCE [1] SYSTEMS FOR EVALUATION OF THE HAZARDS OF BULK WATER TRANSPORTATION OF INDUSTRIAL CHEMICALS

This study classifies the hazards of bulk water transportation of industrial chemicals in each of nine categories (see Table 14). The hazard rating of an industrial chemical is evaluated independently for each category. However, no ranking of chemical hazard by combining the category ratings into one overall figure can be justified.

The fire hazard rating, Category 1, classifies those chemicals with a flash point of less than 100° F and a boiling point of less than 100° F as "extremely hazardous", while those chemicals with a flash point less than 100°F and a boiling point greater than 100°F are classified as "highly hazardous."

Categories II through V are occupational health hazard ratings. The hazard of liquid contact with skin and eyes is classified in Category II. Those chemicals having a dermal LD_{50} of less than 20 mg/kf are classified as "extremely hazardous," while those chemicals with an LD_{50} of greater than 20 mg/kg, but not more than 200 mg/kg, are classified as "highly hazardous."

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[1] System for Evaluation of the Hazards of Bulk Water Transportation of Industrial chemicals; a Report to the Department of Transportation, United States Coast Guard. Washington, National Academy of Sciences -- National Research Council, Fed. 1974. 42 p. (Distributed by National Technical Information Service, Springfield, Va., AD-782 476).

The hazard rating for the short-term inhalation of gas or vapor, Categories III and IV, classifies those chemicals with an inhalation LC_{50} of less than 50 ppm or less than 0.5 mg/l as "extremely hazardous", while those chemicals with a LC_{50} of greater than 0.5 mg/l, but not more than 2 mg/l, are classified as "highly hazardous."

The hazardous rating for repeated inhalation of gases and vapors, Category V, is based on Title 29 (Labor), CFR, Sec.. 1910.93. Those substances listed in specified tables or regulated elsewhere in this section, having an 8-hour time weighed average exposure limit of less than 1 ppm are classified as "extremely hazardous," while those substances having an exposure limit of more than 1 ppm but not more than 10 ppm are classified as "highly hazardous."

Water pollution hazard ratings, Categories VI, and VII, are concerned with the toxicological dangers, to humans and to aquatic life, associated with a chemical spilled or dumped into wasterways. Those chemicals with an oral LD_{50} of less than 5 mg/kg are classified as "extremely hazardous," while those chemicals with oral LD_{50} of more than 5 mg/kg, but not more than 50 mg/kg, are classified as "highly hazardous". Substances having a 96-hour aquatic life LC_{50} (or median threshold limit, TLm) of less than 1 mg/l are classified as "highly toxic". These ratings do not address the problem of bioaccumulation.

Reactivity hazard ratings, Categories VIII and IX, are concerned with the likelihood of chemical reaction with water, or chemical self-reaction, usually via polymerization. The "extremely hazardous" water reaction hazard rating is classified as a violent reaction of a chemical with an equal weight of waster in a tank at ambient temperature. The "highly hazardous" rating is assigned to those chemicals that undergo a vigorous reaction with water under similar conditions. Chemicals that can undergo self-oxidation and/or polymerization, possibly causing explosions or detonations, are classified as "extremely hazardous." Chemicals that may undergo self-reaction, and require special handling, such as incorporation of a stability or polymerization inhibitor, are classified as "highly hazardous".

3.3 BATTELLE MEMORIAL INSTITUTE[1] PROGRAM FOR THE MANAGEMENT OF HAZARDOUS WASTES

Battelle utilized a decision model (Figure 11) in determining which waste streams should be designated as hazardous. All waste streams were candidates for hazardous waste designation, regardless of production quantities.

A waste stream meeting any of the following criteria was designated as hazardous:

1. Radioactivity: waste streams containing radioisotopes above the accepted maximum permissible concentration (MPC) levels set by the Atomic Energy Commission (now the Nuclear Regulatory Commission).
2. Bioconcentration: materials for which the detoxification-excretion mechanism is either non-existent or extremely slow, (these materials can be categorized as either heavy metals or persistent organic materials).
3. Flammability: waste streams qualifying as Category 4 flammable materials by the National Fire Protection Association (NFPA No. 704M). The classification is roughly equivalent to Grade 4 of the National Academy of Sciences (NAS) fire hazard scale mentioned earlier. Generally, materials qualify as Category 4 flammable if they are:
   - (a) flammable gases;
   - (b) flammable liquids with boiling points or flash points below 100°F and vapor densities greater than or equal to 1.1, or
   - (c) spontaneously combustible in air.

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[1] Program for the Management of Hazardous Wastes for Environmental Protection Agency, Office of Solid Waste Management Programs; final report. Richland, Washington, Battelle Memorial Institute, July, 1973, 385 p.

4. Reactivity: materials which in themselves are capable of detonation or of explosive decomposition or explosive reaction at normal temperatures and pressures, Category 4 of NFPA, (No. 704M). The major areas of concern include:

   (a) Detonation by electrical shock; pertinent data can be found in the National Electric Code, (NPFA No. 70);

   (b) Oxidizing materials, includes Grade 4 self-reactive materials in the NAS rating system;

   (c) Polymerization; hazardous wastes capable of auto-polymerization, includes Grade 3, self-reactive agents in NAS ratings;

   (d) Explosiveness; primary high explosives rated at five inches or less on the Picatinny Arsenal scale, and

   (e) Water or air reactive wastes; includes material rated as Grade 4 water reactive in the NAS rating system.

5. Oral Toxicity: waste streams having an oral LD_{50} to man or rats less than or equal to 50 mg/kg. Test data for species other than humans or rates, or by routes of administration other than oral are used to estimate an oral value for man or rats in the absence of such data.

6. Inhalation toxicity: waste having an inhalation LC_{50} of 200 ppm or less as a vapor or 2 mg/l or less as a dust or mist.

7. Dermal penetration: wastes having a dermal LD_{50} or 50 mg/kf or less.

8. Dermal irritation: wastes scoring eight or better on the FDA skin irritation scale (Title 21, CFR, Sec. 191.11), or a rating of eight or better on the 10-grade scale devised by Smyth, et al. A grade eight rating on the latter scale represents severe irritant effects after a dilution of 100 to 1.

9. Aquatic Toxicity: wastes displaying a 96-hour TLm of 1,000 ppm or less. This level was based on thresholds then being proposed by EPA pursuant to Sec. 311 of the FWPCA. The proposed threshold for aquatic life was subsequently revised to a 96-hour TLm of 500 ppm, (Federal Register, Vol. 39, No. 164, August 22, 1974).

10. Thytotoxicity: wastes having a mean inhibitory limit, (ILm) of 1,000 ppm or less. This level was chosen for reasons similar to those for selection of the aquatic toxicity threshold. Also, the proposed threshold for aquatic flora was subsequently revised to an ILm of 100 ppm, (see previous reference).

11. Genetic effects: wastes found to give positive results to standard genetic tests. Standard tests for determining carcinogenic, mutagenic, or teratogenic potential have been developed by the National Cancer Institute.

The decision model just outlined is designed to evaluate entire waste streams. Unfortunately, very little waste stream data has been collected to date. Lacking such data, many classification systems rely on the pure compound approach, successive testing of each waste stream constituent, for determining whether or not a waste stream should be designated as hazardous. Battelle employs a variant of this approach for classifying waste streams. An assumption is made that all constituents are additive in their effects. The additive estimation of toxicity levels for waste streams is calculated by use of the following model:

$$1/Y \text{ waste} = \sum_{x=1}^{a} Px/Yx$$

where "Y" is the toxicity measurement, i.e., TLm, ILm, oral or dermal LD_{50} or inhalation LC_{50}, and "Px" is the fraction of constituent "x" in the waste stream.

Clearly, otoxicological data are not always additive. Smyth, et al. found that oral LD_{50} values for combined organic solvents were quite close to predicted values. For materials with distinctly different toxic effects, the estimated limit serves as a maximum unless synergism comes into play.

For other than toxicological measurements, the additive estimate is not as neatly calculated for the waste stream. Greater subjective judgment for estimating an entire waste stream's flammability, reactivity, or dermal irritation ratings is required. Evaluation of a waste stream's postential for bioconcentration and genetic activity is quite difficult, making the additive estimations techniques highly judgmental.

3.4 BOOZ-ALLEN APPLIED RESEARCH, INC.[1] A STUDY OF HAZARDOUS WASTE MATERIALS, HAZARDOUS EFFECTS AND DISPOSAL METHODS

This report evaluated the degree of hazard associated with a substance in terms of its potential effect on human health and welfare and on other ecological populations. The human health and welfare category includes effects from flame, explosion, or reaction, as well as toxic effects resulting from exposure to a given substance. The category involving other ecological populations documents the toxic effects resulting from plant or animal exposure to a given substance. The degree of hazard for each disposal or release medium (air, water, and soil) is evaluated in terms of the potential effects just described. The matrix of factors used for rating the level of effects for potentially hazardous substances is depicted in the following table:

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[1] Booz-Allen Applied Research, Inc. A Study of Hazardous Waste Materials, Hazardous Effects and Disposal Methods. U.S. Environmental Protection Agency, 1973. 3 v. (Distributed by National Technical Information Service, Springfield, Va., as PB-211 464).

Medium for Disposal	Hazard in Terms of Potential Effects Human Populations		Eco Populations
	Toxic Effects (Th)	Flame/Explosion/ Reaction (Fh)	Toxic Effects (Te)
Air (A)	ATh	AFh	ATe
Water (W)	WTh	WFh	WTe
Soil (S)	STh	SFh	STe

Each element of the above matrix is rated using the following scale:

3-Severely hazardous

2-Slight to moderate hazardous

1-Minimal hazard

U-Effects unknown

The acute exposure criteria used in designating a substance as severely hazardous for each of the nine elements depicted in the previous table were as follows: (Chronic exposure criteria, arbitrarily assumed to be 1/20 to 1/100 of acute exposures, were also used in designating a substance as severely hazardous).

ATh: inhalation $LC_{50} \leq 5{,}000$ mg/m3; or TLV ≤ 500 mg/m3

WTh: oral $LD_{50} \leq 50$ mg/kg; or TLV ≤ 5 mg/kg

STh: severely hazardous percutaneously on direct contact.

AFh: Fp $\leq 100^{\circ}$F and Bp $\leq 100^{\circ}$F; spontaneous combustion and/or explosive reaction

WFh: reacts explosively with water without requiring heat or confinement

SFh: readily capable of detonation and explosive decomposition or reaction at normal ambient temperatures and pressures

ATe: inhalation $LC_{50} \leq 2000$ mg/m3; or TLV ≤ 200 mg/m3

WTe: TLm $\leq$ 100 mg/l; or TLV $\leq$ 10 mg/l

STe: highly lethal on contact to most vegetation and/or earth organisms.

NOTE: No time limit for any toxicity measurement, LC_{50}, LD_{50} or TL), was given. Also, the definition of TLV was expanded to include that dose (mg/kg body weight) to which humans or animals may be exposed repeatedly or continuously day after day without suffering adverse effects.

Once ratings for a particular substance have been developed for each element in the potential effects matrix, they are summed vertically and horizontally to give a total effects rating. Production and distribution rating criteria are then factored into the calculation according to the following scales:

Production Rating Criteria

1.5 - Large population, amounts exceeding 10^8 pounds (50,000 short tons), annually.

1.25 - Moderate production, amounts at least 10^7 pounds (5,000 short tons), but less than 10^8 pounds annually.

1.0 - Low production, amounts less than 10^7 pounds.

U - Unknown

Distribution Rating Criteria

0.5 - Wide distribution, more than 10 major producers, shipments in less than tank car containers, used as both intermediate industrial and consumer product.

0.25 - Moderate distribution, 5-10 major producers, large shipments.

0.0 - limited distribution, less than 5 major producers.

The final hazard rating is derived by multiplying the sum of the production and distribution ratings by the total effects rating. Additionally, a maximum potential hazard rating is calculated by assigning a maximum hazard value of three for each unknown and incorporating this factor into the total effects rating.

CHAPTER FOUR

HAZARDOUS WASTE CATEGORIZATION BY INTERNATIONAL ORGANIZATIONS

Hazardous waste categorization by any international organizations has not been as yet undertaken. Rather, all of the international organizations have undertaken only various planning studies which would ultimately lead to the hazardous waste categorizations schemes.

The various planning efforts undertaken by the international organizations are summarized in Appendix B.

Specifically, planning activities of the following organizations are described:

1. United Nations Environment Programs (UNEP)
    - 1.1 INFOTERRA
    - 1.2 Codex Alimentarius Commission
    - 1.3 WHO Environmental Health Criteria Program
    - 1.4 WHO/FAO Pesticides Program
2. North Atlantic Treaty Organization (NATO) Committee on the Challenges of Modern Society
    - 2.1 Hazardous Waste Analyses by NATO's Member Countries
3. International Agency for Research on Cancer (IARC)
4. International Registrar of Potentially Toxic Chemicals (IRPTC)
5. The Organization for Economic Cooperation and Development (OECD); and
6. The European Economic Community (EEC)
    - 6.1 Environmental Chemicals Data and Information Network (ECDIN)

CHAPTER FIVE

HAZARDOUS WASTE CATEGORIZATION BY INTERNATIONAL NON-GOVERNMENT ORGANIZATIONS

Several international non-government organizations have undertaken effort related to hazardous waste categorization. These are as follows:

1. Scientific Committee on Problems of the Environment (SCOPE)
2. The International Academy for Environmental Safety (IAES)
3. International Center for Industry and Environment
4. The International Commission for the Protection Against Environmental Mutagens and Carcinogens (IC-PEMC)
5. The European Chemical Industry Ecology and Toxicology Center (EC-ETOC)
6. The Oil Companies International Study Group for Conservation of Clear Air and Water in Europe (CONCAWE)

The research effort by some of these groups has not resulted as yet in hazardous waste categorization. The reader is urged to consult Appendix C for details of the research effort undertaken by these organizations.

CHAPTER SIX

HAZARDOUS WASTE CATEGORIZATION SCHEMES IN SITU OF DEPOSITORY

As presented in Chapter I of this report, the EPA, various industry sectors affected by hazardous waste regulation, and the Congress have been concerned with issues related to hazardous waste depositories in general, and with types and management of depositories and related issues in particular. Further, the EPA proposes to establish waste hazard categories by classification of hazardous waste depositories by type. It is thus surprising that only very limited analyses have been initiated on the hazardous waste categorization by degree of hazard _in situ_, i.e., after the hazardous waste is placed in the final waste treatment facility.

Specifically, a comprehensive survey of all pertinent material disclosed only two information sources on this subject. The first source consists of a significant discussion on potential dangers of certain mixtures of hazardous waste by the Counsel of European Countries. This material is presented in Appendix B.

The second source of information is comprised of several preliminary studies undertaken by the EPA or by contractors working for the Agency. These studies are summarized in the following section of this chapter.

6.1 RATING THE HAZARD POTENTIAL OF WASTE DISPOSAL SITES

The Environmental Protection Agency has attempted over a period of some time to rate hazard potential of waste disposal sites.[1/] While this effort to establish hazard potential of waste disposal sites by the EPA is continuing, this section presents the rating methodology as it is currently (Fall, 1980) used.

The site rating methodology has been developed in terms of six elements:

- Generic areas
- Rating factors
- Rating scales
- Multipliers
- Additional points
- Hazard potential scores

6.1.1 Generic Areas

In assessing the environmental impacts of any hazardous waste disposal site, four Generic Areas of consideration must be addressed:

- Receptors
- Pathways

[1/] See, for example: "Setting Priorities for Activities Relative to Hazardous Waste Sites", Memorandum from Kenneth E. Biglane, Director, Oil and Special Materials Control Division, EPA, March 21, 1980 and JRB Associates, Inc., Methodology for Rating the Hazard Potential of Waste Disposal Sites, prepared for EPA May 5, 1980.

- Waste Characteristics
- Waste Management Practices

Receptors refers to the biota (human and non-human) which are potentially affected by the materials released from a waste disposal site. Within this generic area, special attention is given to human populations and critical environments. Pathways refers to aspects of the routes by which hazardous materials can escape from a given site. The focus of this category is on the ease of migration of water soluble pollutants and on contamination due to the site. Waste Characteristics refers to the types of hazards posed by materials in the facility in terms of both their health-related effects and their environmental mobility. Waste Management Practices refers to the design characteristics and management practices of a given disposal site as they relate to the site's environmental impact. In particular, this area examines measures that are being taken to minimize exposure to hazardous wastes.

The prime importance of Generic Areas is in partitioning the Rating Factors into manageable groups so that site ratings can be more easily and completely interpreted.

6.1.2 Rating Factors

The actual ratings of a waste disposal facility are based on a set of 31 Rating Factors. Each of these has been assigned to one of the four generic areas. The Receptors generic area has five rating factors:

- "Residential population within 1,000 feet" and "Distance to the nearest off-site building" measure the potential for human exposure to the site.

- "Distance to the nearest drinking-water well" measures the potential for human ingestion of contaminants should underlying aquifers be polluted.

- "Land use/zoning" evaluates the current and anticipated uses of the surrounding area.

- "Critical environments" assesses the potential for adversely affecting important biological resources and fragile natural settings.

The Pathways generic area contains nine rating factors concerned with contaminant migration and attenuation potential. The primary focus is on waterborne pollutants, since they can affect the greatest number of people.

- "Distance to the nearest surface water" and "Depth to groundwater" measure the availability of pollutant migration routes.

- "Soil permeability," "bedrock permeability," and "depth to bedrock" measure the potential for contaminant attenuation and ease of migration.

- "Net precipitation" uses annual precipitation and evapotranspiration to estimate the amount of leachate a site produces.

- "Evidence of contamination," "type of contamination," and "level of contamination" evaluate pollution currently apparent at the site.

The Waste Characteristics generic area contains rating factors which examine the waste's environmental mobility and the adverse effects they can cause.

- "Solubility," "volatility," and "physical state" measure the extent to which mobile wastes can leave the site.

- "Toxicity." "radioactivity," and "persistence" assess the site's potential to cause health-related injuries.
- "Ignitability," "reactivity," and "corrosiveness" evaluate the possibility of fire, explosion, or similar emergencies.

The Waste Management Practices generic area evaluates site design and operation. This generic area includes eight rating factors:

- "Use of leachate collection systems," "use of gas collection systems," and "use of liners" examine features of site design for containing contamination.
- "Site security" assesses the measures taken to limit site access.
- "Total waste quantity" and "hazardous waste quantity" measure the quantity of waste in the site and thus, the potential magnitude of resulting contamination.
- "Waste incompability" evaluates the potential for incompatible wastes to combine and pose a hazard.
- "Use of containers" assesses the adequacy of waste containers to isolated wastes.

These factors have been selected because they are relevant to an evaluation of any land-based disposal facility. The definition and purpose of each rating factor is presented below.

6.1.3 Receptors

Population within 1,000 feet is a rough indicator of the potential hazard exposure of the residential population near the site. It is measured from the site boundaries on all sides. Where only houses can be counted (e.g., from an aerial photograph), it can be computed using 3.8 individuals per dwelling unit.

Distance to nearest drinking water well is the distance between a site and the nearest downgradient building that is unlikely to be served by a public water supply (e.g., farmhouses).

Distance to nearest offsite building is a direct indicator of potential property damage and an indirect measure of potential human exposure. The building's use is considered under the Additional Point System, and not in assessing this factor.

Land use/zoning is intended to indicate the nature and level of human activity in the vicinity of the site. Impending change in the zoning or land use should be noted in rating the site.

Critical environment is an environment which contains important biological resources, or which is a fragile natural setting that will suffer an especially severe impact from pollution.

6.1.4 Pathways

Evidence of contamination indicates how confident the rater is of his contamination information.

Level of contamination signifies how readily apparent and severe a sites hazards are. In addition, it provides a rough indication of the concentration of contaminants at the site.

Type of contamination indicates what media have been contaminated by a site. Since this methodology is for land-based disposal sites, it is assumed that when air or water is contaminated, then so is the biota. And when the biota is contaminated, then so is the soil.

Distance to the nearest surface water is the shortest distance from the perimeter of the site to the nearest body of surface water (e.g., lake or stream) which periodically contains water. This measure provides an indication of the ease with which pollutants may flow overland to surface water bodies.

Depth to groundwater is measured vertically from the lowest point of the filled wastes to the highest point of the seasonal water table. This factor provides an indication of the ease with which a pollutant can contaminate groundwater.

Net precipitation provides an indication of the potential for leachate generation at a site. It is equal to the mean annual precipitation minus the annual evapotranspiration.

Soil permeability indicates the speed at which a contaminant could migrate from a site. In addition, when considered with soil thickness and permeability, this measurement can indicate how likely the contaminant is to be attenuated through soil filtration. The following table gives approximate permeabilites of various soil textural classes and the level assigned to each.

JRB LEVEL	TEXTURAL CLASSES	APPROXIMATE PERMEABILITY cm/sec
3	Sand, Loamy Sand, Sandy Loam	$>10^{-2}$
2	Loam, Silt Loam, Silt	$10^{-2} - 10^{-4}$
1	Sandy Clay, Clay Loam, Silty Clay Loam, Sandy Clay Loam	$10^{-4} - 10^{-5}$
0	Clay, Silty Clay	$<10^{-6}$

Bedrock permeability is another indicator of the ease and rapidity with which pollutants can migrate from a site. The following table will aid the rater in evaluating this factor.

JRB LEVEL	ROCK TYPES	APPROXIMATE PERMEABILITY cm/sec
3	Any well-fractured rock carbonates and evaporites (in humid climates), volcanic igneous rocks (except basalt)	$>10^{-2}$
2	Any slightly fractured rock, uncemented and weakly cemented sandstones, and conglomerates	$10^{-2} - 10^{-4}$
1	Siltstones, moderately and well cemented sandstones, and conglomerates	$10^{-4} - 10^{-5}$
0	Unfractured shales, metamorphic and igneous rocks (except volcanics), carbonates and evaporites in an arid climate	$<10^{-6}$

Depth to bedrock is the thickness of the overburden (soil and weathered rock) at the site. This provides a measure of the potential for pollutant attenuation through filtration and soil reactions when coupled with soil permeability.

6.1.5 Waste Characteristics

Toxicity levels are excerpted from:

- Hazardous Properties of Industrial Materials by N.I. Sax; and
- National Fire Protection Association's Guide on Hazard Materials.

6.1.6 Sax's Toxicity Ratings

"In Section 12 in this book, the following system of toxicity ratings is used to indicate the relative hazard:

U = Unknown

This rating has been assigned to chemicals for which insufficient toxicity data were available to enable a valid assessment of hazard to be made. These compounds usually are in one of the following categories:

(a) No toxicity information could be found in the literature and none was known to authors.

(b) Limited information based on animal experiments was available but in the opinion of the authors this information could not be applied to human exposures. In some cases this information is mentioned so that the reader may know that some experimental work has been completed.

(c) Published toxicity data were felt by the authors to be of questionable validity.

0 = No Toxicity

This designation is given to materials which fall into one of the following categories:

(a) Materials which cause no harm under any conditions of normal use.

(b) Materials which produce toxic effects on humans only under the most unusual conditions or by overwhelming dosage.

1 = Slight Toxicity

(a) Acute local. Materials which on single exposures lasting seconds, minutes, or hours cause slight effects on the skin or mucuous membranes regardless of the extent of the exposure.

(b) Acute systemic. Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which produce only slight effects following single exposures lasting seconds, minutes, or hours, or following ingestion of a single dose, regardless of the quantity absorbed or the extent of exposure.

(c) Chronic local. Materials which on continuous or repeated exposures extending over periods of days, months, or years cause only slight and usually reversible harm to the skin or mucous membranes. The extent of exposure may be great or small.

(d) Chronic systemic. Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which produce only slightly usually reversible exposures extending over days, months, or years. The extent of the exposure may be great or small.

In general, those substances classified as having "slight toxicity" produce changes in the human body which are readily reversible and which will disappear following termination of exposure, either with or without medical treatment.

2 = Moderate Toxicity

(a) Acute local. Materials which on single exposure lasting seconds, minutes, or hours cause moderate effects on the skin or mucous membranes. These effects may be the result of intense exposure of a matter of seconds or moderate exposure for a matter of hours.

(b) Acute systemic. Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which produce moderate effects following single exposures lasting seconds, minutes, or hours, or following ingestion of a single dose.

(c) Chronic local. Materials which on continuous or repeated exposures extending over periods of days, months, or years cause moderate harm to the skin or mucous membranes.

(d) Chronic systemic. Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which produce moderate effects following continuous or repeated exposures extending over periods of days, months, or years.

Those substances classified as having "moderate toxicity" may produce irreversible as well as reversible changes in the human body. These changes are not of such severity as to threaten life to produce serious physical impairment.

3 = Severe Toxicity

(a) Acute local. Materials which on single exposure lasting seconds or minutes cause injury to skin or mucous membranes of sufficient severity to threaten life or to cause permanent physical impairment or disfigurement.

(b) Acute systemic. Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which can cause injury of sufficient severity to threaten life following a single exposure lasting seconds, minutes, or hours, or following ingestion of a single dose.

(c) Chronic local. Materials which on continuous or repeated exposures extending over periods of days, months, or years can cause injury to skin or mucous membranes of sufficient severity to threaten life or cause permanent impairment, disfigurement, or irreversible change.

(d) Chronic systemic. Materials which can be absorbed into the body by inhalation, ingestion or through the skin and which can cause death or serious physical impairment following continuous or repeated exposures to small amounts extending over periods of days, months, or years.

6.1.7 N.F.P.A.'s Toxicity Ratings

0 Materials which on exposure under fire conditions would offer no health hazard beyond that of ordinary combustible material.

1 Materials only slightly hazardous to health. It may be desirable to wear self-contained breathing apparatus.

2 Materials hazardous to health, but areas may be entered freely with self-contained breathing apparatus.

3 Materials extremely hazardous to health, but areas may be entered with extreme care. Full protective clothing, including self-contained breathing apparatus, rubber gloves, boots and bands around legs, arms and waist should be provided. No skin surface should be exposed.

A few whiffs of the gas or vapor could cause death; or the gas, vapor, or liquid could be fatal on penetrating the fire fighters' normal full protective clothing which is designed for resistance to heat. For most chemicals having a Health 4 rating, the normal full protective clothing available to the average fire department will not provide adequate protection against skin contact with these materials. Only special protective clothing designed to protect against the specific hazard should be worn.

Radioactivity is evaluated in terms of background radioactivity. Background radioactivity is the level of radiation due to natural sources such as cosmic rays, building materials, and naturally radioactive materials in soil and rock. To determine background radiation levels, the investigator should use radiation detection devices such as scintillation detectors and measure the radiation levels at some location close to the site, but not affected by wastes deposited in the site. The elevation of the location where background is measured should be similar to that of the site. This background level is then compared with that found on the site and rated accordingly.

Persistence is evaluated on the biodegradability of the wastes. In rating this factor, the most persistent compound should be chosen. A guide for evaluating this factor for organics can be found in Table 15.

Ignitability. This factor provides an indication of the threat posed by fire at a site, and is based on the flammability classification of the National Fire Protection Association.

Corrosiveness is based on the pH of the wastes and indicates the potential for damage to equipment, fixtures, and any organisms that may contact these wastes.

Solubility signifies how easily contaminants can mix with water, and thus, how readily they can migrate from the site by way of surface and ground waters. It is based on the CRC Handbook of Chemistry and Physics as follows:

JRB LEVEL	CRC LEVEL
3	V - Very soluble, infinitely soluble, or miscible
2	S - Soluble
1	δ/s^h - Slightly soluble
0	I - Insoluble

Votatility is a measure of a disposed material's tendency to change from a liquid, solid, or semi-solid state, directly to a gaseous state under normal ambient conditions of temperature and pressure. Voltaility thus provides a means of rating the potential for air pollution problems due to the disposed material. The material's vapor pressure is the most readily available relative measure of this tendency. Unknown chemical odors at a site should be rated at least a "1" in the absence of more definite data.

Physical state refers to the state of the wastes at the time of disposal. Gasses generated by the wastes in a disposal area should not be considered in rating this factor.

6.1.8 Waste Management Facilities

Site security is an indication of the positive actions that have been taken to limit the exposure of people and animals to waste-related hazards.

Hazardous waste quantity indicates a greater potential hazard for sites with large amounts of hazardous wastes. As an aid in estimating this value, amounts are expressed in three units below. On occasion, raters may have to convert several pieces of quantity data to a common unit in order to add them together.

JRB LEVEL	VOLUME CUBIC YARDS	WEIGHT SHORT TONS	DRUMS 55 GALLON
3	>2370	>2000	>650
2	1191 - 2370	1001 - 2000	326 - 650
1	300 - 1190	250 - 1000	80 - 325
0	<300	<250	<80

Total waste quantity is used as an indication of a site's size, and in conjunction with Hazardous Waste Quantity as an estimate of what proportion of the total wastes is hazardous. Additional volume units are given below. Raters can estimate a site's total waste quantity by multiplying the area of the site (in acres) by the average thickness of the wastes (in feet) to obtain acre-feet.

JRB LEVEL	ACRE-FEET	CUBIC YARDS
3	>250	>400,000
2	100 - 250	161,000 - 400,000
1	10 - 100	16,000 - 161,000
0	<10	<16,000

Waste incompatibility can lead to explosion, fire, and the production of toxic fumes. A table of incompatible wastes is included in Table 16 as an aid in evaluating this factor.

Use of liners provides an indication of improvement on the impermeability of natural soils occurring at the site. Although there are wide variations in liner quality and durability, the presence of a liner indicates that an effort was made to reduce or eliminate migration of contaminants, which is a positive factor in the evaluation of disposal sites.

Use of leachate collection systems indicates that action has been taken to prevent groundwater contamination problems. Hence, it should be viewed as a positive factor in the rating of disposal sites. Raters must judge on a case-by-case basis what constitutes "adequate" collection and treatment.

Use of a gas collection system is another positive factor that indicates an effort is being made to control the release of pollutants from a site. Sampling and rater judgment may be necessary to determine adequacy of collection and treatment.

Use and condition of containers provides an indication of whether wastes were dumped in bulk or in containers, and the intergrity of the containers used. Containers retard the release of pollutants to the environment providing they are intact.

6.1.9 Rating Scales

For each of the factors, a four-level rating scale has been developed which provides factor-specific levels ranging from "0" (indicating no potential hazard) to "3" (indicating a high potential hazard). The rating factors along with their corresponding rating scales for each of the generic areas are listed in Table 17. These scales have been defined so that the rating factors can typically be evaluated on the basis of readily available information from published materials, public and private records, contacts with knowledgeable parties, or site visits. Raters compare the information collected for a site with the limits set in the scales and see which level of each scale most closely fits the information. The numeric value of that level is the site rating for that factor.

6.1.10 Multipliers

The rating factors do not all assess the same magnitude of potential environmental impact. Consequently, a numerical value has been assigned to each factor in accordance with the relative magnitude of impact that it does assess. These values are multiplied (hence the term multiplier) by the appropriate site ratings to result in site scores for each of the rating factors.

6.1.11 Additional Points

Special features of a facilitiy's location, design, or operation are frequently encountered that cannot be handled satisfactorily by rating factors. These features might present hazards that are unusually serious, unique to the site, or not assessable by rating scales. For example, an extremely high population density near a site should be considered even more hazardous than the rating factor for "population within 1000 feet" indicates. Power lines running through sites that contain explosive or flammable wastes, though not typical of waste disposal sites in general, should be considered a potential hazard. Finally, the function of the nearest off-site building might indicate a serious threat of human exposure exists, even though types of functions cannot be quantitatively evaluated by rating scales the way distance can be. In such cases, raters should assign a greater hazard potential score to a site than it might otherwise receive by using the additional points system. To guide raters as to the types of situations that might warrant additional points, several examples have been identified for each of the generic areas. These are:

RECEPTORS

- Use of site by local residents
- Neighboring land use
- Neighboring transportation routes, drinking water supplies, and important natural resources.

PATHWAYS

- Extreme runoff and erosion problems
- Slope instability
- Flooding
- Seismic activity

WASTE CHARACTERISTICS

- Carcinogenicity, mutagenicity, and teratogenicity
- Infectiousness
- Low biodegradability
- High-level radioactivity

WASTE MANAGEMENT PRACTICES

- Excessively large waste quantities
- Open burning of wastes
- Site abandonment
- Unsafe disposal practices
- Inadequate cover
- Inadequate safety precautions
- Inadequate recordkeeping

While this list is by no means exhaustive, and other examples may be encountered by raters using the methodology, it does include the more commonly occurring situations.

In order to maintain the objectivity of the rating methodology while allowing the assignment of additional points, the following limits have been placed on the number of additional points that can be assigned in each generic area:

• Receptors	50 points
• Pathways	25 points
• Waste characteristics	20 points
• Waste management practices	30 points

The number of additional points allowed in each generic area is a function of the number of rating factor points available and the relative importance of the generic area.

Hazard Potential Scores

The result of a site rating is a set of five hazard potential scores. These scores are:

- Overall score
- Receptors subscore
- Pathways subscore
- Waste characteristics subscore
- Waste management practices subscore

The overall score is based on all the rating factors and additional points that are used to rate a site. Each subscore is based on those rating factors and additional points used to rate a site in that generic area. All of these scores are normalized on a scale of 0 to 100. Associated with every hazard potential score is a percentage of missing and assumed data. These percentage flag scores are based on large amounts of missing data and, in a general way, measure the reliability of the scores.

CHAPTER SEVEN

RISK ANALYSIS OF HAZARDOUS WASTES

The scope of work of this project included a review of pertinent risk studies and analysis of whether or not the disposal of hazardous wastes is accomplished in the manner prescribed by risk studies.

The underlying objective of this research effort was obtain useful information on hazardous waste management from various risk analyses which are used increasingly for public policy decisions, management of government policies and risk-benefit analyses.

The fact that many of the risk analyses with increasing frequency focused on various hazardous wastes[1] and/or materials provided additional expectations that review of pertinent literature would provide much useful information.

In order to accomplish this research objective, an analysis of various studies was undertaken to locate analyses and recommendations on hazardous waste disposal practices. These analyses were supplemented by review of two bibliographical sources: The National Technical Information System (NTIS) and Smithsonian Science Information Exchanges "Notices of Research Project."

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[1] For example, Stanford Research Institute, Hazardous Wastes: A Risk-Benefit Framework Applied to Codminum and Asbestos, Melno Park, California, 1975.

Over 300 studies were reviewed in detail. The results were disappointing in that none of the reviewed studies focused on risk analysis of specific chemicals, compounds or groups of compounds. Also, the studies did not specify issues of disposal considerations or practices in a systematic manner which would add to the knowledge of these issues.

Rather, the emphasis in these risk analyses studies was usually placed on the risk-benefit considerations to society from the point of view of public exposure to the risks associated with the use, application and consumption of specific chemicals, compounds or group of compounds. This observation does not imply that risk analyses which explicitly deal with societal risks associated with hazardous waste disposal do not exist. On the contrary, numerous comprehensive studies that analyze risk associated with hazardous waste disposal practices have been made. However, these studies emphasize hazardous waste disposal methods and therefore deal mostly with these issues in generic terms rather than explore risks and prescribe appropriate disposal methods for specific chemical(s), compounds or groups of compounds.

CHAPTER EIGHT

CRITICAL REVIEW OF WASTE CATEGORIZATION SCHEMES BY DEGREE OF HAZARD

This report summarized various attempts to develop a degree of hazard categorization schemes of hazardous wastes by various organizations in the U.S. and abroad. The material clearly indicates a lack of such schemes. Organizations abroad have not developed a comprehensive scheme to categorize hazardous wastes by degree of hazard, although considerable effort has been and is being made to design such schemes for future use.

In the U.S., four States have adopted such schemes and the EPA has received a number of proposals - some of them quite comprehensive - for development of degree of hazard classification of hazardous wastes. Conversely, the key U.S. Federal Government Agency responsible for development of such a scheme, i.e., the EPA, has admitted that such schemes cannot be readily developed. This chapter presents a critical review and comparison of the degree of hazard schemes that have been developed or proposed.

8.1 SALIENT ISSUES OF DEGREE OF HAZARD SCHEMES

Survey of the literature of hazardous waste management and degree of hazard schemes suggests that three principal and related reasons exist for the development and implementation of such schemes.

The first reason pertains to public health and well-being. Hazardous wastes are not homogeneous with regard to the risk to public health and welfare; some wastes pose more direct and immediate health threats than others and therefore require more care in management of the disposal.

The second reason is essentially economic in nature. Disposal of hazardous wastes is a costly undertaking; costs increase rapidly and in more or less proportion to the degree of hazard of waste. Simple logic dictates that under such conditions it would be economically prudent to dispose less hazardous wastes in a less costly manner and still provide adequate safety to the public; and to increase the public safety and disposal costs for wastes that are more hazardous.

The third reason for degree of hazard scheme is that only a limited and finite number of appropriate sites exist where hazardous wastes can be disposed without injury to the public.

Given these constraints, an appropriate public policy would designate more hazardous wastes to the most appropriate disposal site and leave less hazardous wastes to less appropriate disposal sites.

Two distinct methods for establishing the degree of hazard of hazardous wastes have been used by various organizations.

The first of these consists of established list(s) of hazardous wastes in terms of degree of hazard. The establishment of such list(s) is presumably accomplished by evaluation of each hazardous waste in terms of its potential risk to the health and safety of the public applying a range of criteria. An excellent example of such method is the hazardous waste categories established by West Germany. The second method for establishing the degree of hazard of hazardous wastes is by use of certain self-imposing characteristics such as the positive mutagenic activity, corrosive characteristics, accumulation potential and many others. The Chemical Manufacturers Association's proposed system for management of hazardous wastes is an example of this method.

In practice both methods are often combined. For example, the Environmental Protection Agency's proposed classification of hazardous wastes (but not by degree of hazard) uses both methods to classify a waste as hazardous. The properties and characteristics of waste that are used to classify the waste as hazardous or to classify the waste by degree of hazard varies, but in most cases consists of several or all of the characteristics listed in Table 18.

In addition to these seven characteristics, hazardous waste classification schemes use other already established standards such as those for drinking water.

Some of the degree of hazard categorization schemes are quite specific, empirical and detailed; others provide only general and qualitative information. This can be readily seen from the example below which provides categorization of Class I Hazardous waste from two proposals for such scheme submitted to the Environmental Protection Agency. One of the proposals states the following waste characteristics for Class I waste:

> "Class I wastes will be classified as such with these characteristics:
>
> (i) Toxicity. The waste contains any concentration greater than (0.10% (100 ppm)) of any material with an oral mammalian LD_{50} of (5 mg/kg or less) or an aquatic (fish) LC_{50} of (1.0 mg/l or less).
>
> (ii) Reactivity. The waste displays any of the following characteristics:
> - (A) Is readily capable of detonation or explosive decomposition or reaction at normal temperatures and pressures, or
> - (B) Is a forbidden explosive as defined in 40 CFR 173.51, a Class A explosive as defined in 49 CFR 173.53-or a Class B explosive as defined in 49 CFR 173.58.
>
> (iii) The following wastes are classified as Class I hazardous wastes, unless it can be demonstrated, pursuant to the procedures under §250.15, that the Administrator's basis for listing the waste does not meet the criteria for listing under §250.12(b).
>
> (2) Identification Method. Oral-rat LD_{50} protocol, based upon the NIOSH Registry of Toxic Effects of Chemical Substances (1976).

The second proposal contains much more qualitative description:

> "Class I - Those wastes which present a serious continuing and persistent hazard to health or to the new environment and which, therefore, require special care in storage, handling, and disposal including, of course, secure landfill disposal area. This would include, for example, recognized carcinogens which have been assessed to pose unreasonable human risk at exposure levels and in situations relevant biodegradability. This also includes highly toxic materials and highly reactive or highly corrosive wastes."

The significant differences in the two proposals for degree of hazard classification are representative in that equally large differences exist regarding many other issues in the proposed and/or existing degree of hazard categorization schemes.

8.2 CRITICAL COMPARISONS OF HAZARD CATEGORIZATION SCHEMES

Table 19 summarizes salient features of a total of sixteen major hazard categorization schemes either in existence or proposed by various organizations and states.

As the information presented in Table 19 clearly indicates, while there are some differences in the design of these hazard categorization schemes, there are significant similarities among these schemes.

The most common element among most of these schemes is the basis for hazard categories. In the majority of schemes the basis for hazard categories are the four hazardous waste determinants proposed by the Environmental Protection Agency:

1) Ignitability;
2) Corrosivity;
3) Reactivity; and
4) Toxicity.

Except for those hazardous waste categorization schemes which define waste hazards in very qualitative terms (such as Proposed Scheme #2 and Proposed Scheme #3), most of the schemes rely on these determinants to categorize wastes by degree of hazard.

Some of the categorization schemes, however, have additional hazard determinants such as infectious wastes or wastes with known carcinogenic properties.

d categorization schemes, the degree of hazard
re augumented by listing of specific hazardous

ndards for hazard categories are for most part
fic properties of the wastes determined using
ratory procedures on waste extracts, as shown in
addition to the laboratory procedures, many of the
schemes depend on other already established standards
al Interim Primary Drinking Water Standards; or
egulations.

the proposed standards for hazard categories for
re complex and require extensive laboratory procedures.
zard categorzation schemes discussed in the previous
is report and summarized in Table 18 contain certain
ich need to be critically reviewed.

l Manufacturers Association (CMA) Scheme

ady noted CMA proposes three hazard categories (high;
ow) and two additional categories, i.e., special
s generated in very large volumes woth low hazard)
ve infectious wastes.

its proposed by CMA for the three principal hazard
ile reasonable according to the Environmental Pro-
y ". . . have no obvious justification." According

to the Agency,a review of the other categorization schemes ". . . reveals numerous other, quite different, toxicity rankings."

The cardinal shortcomings of the CMA proposed scheme according to the Agency is that the hazard ranking proposed did not consider potential human health and environmental impacts in the event there are past hazardous waste management practices. However, the Agency does admit that the linkage between hazard categories and potential mismanagement of hazardous waste is difficult if not impossbile to establish. In this regard within the following statement by the Agency ". . . the Agency knows of no way to appropirately make these links in a comprehensive degree of hazard ratings." Further, the Environmental Protection Agency believes that while CMA has considered in its hazard ratings the intrinsic hazard of waste and the exposure (try considering such factors as persistence and bioaccumulating of waste) CMA has failed to consider in its ratings. . ." numerous site specific factors which cannot be adequately considered in a national hazard ranking; and the Agency notes that . . ." the site specific conditions have a more significant impact on exposure and risk than the . . . CMA's . . . suggested hazard ranking."

Clearly, if the Environmental Protection Agency's views in this matter are carried to their logical conclusion,no degree of hazard categorization schemes are possible because the exposure component of the hazard will always depend on the uniquely specific characteristics of the disposed site such as hydroecology, cover design, depth of groundmeter, soil type, etc.

8.2.2 Proposed Scheme #2

This hazardous waste categorization shceme is based on. coupling of significant quantitative and concentration of hazardous wastes and of exposure effect. It is very similar to the hazardous waste categorization scheme used by the State of Washington and has a number of shortcomings which need to be discussed. The first of these is that the hazard categories of waste are determined by use of only one waste characteristic: that of toxicity. The other pertinent waste characteristics are not used in hazard category ranking.

The six hazard categories defined, i.e., six levels of toxicity are not based on well established rationale. This categorization scheme assumed only land disposal management alternatives; other disposal methods are not condsidered.

The specific management methods associated with each of the six levels of toxicity are not provided.

Finally, this scheme requires extensive and expensive laboratory analyses for persistence and bioaccumulation. The Environmental Protection Agency also noted that this scheme like the one proposed by CMA fails to take into account the specific characteristics of the site.

8.2.3 Proposed Scheme #3

This hazard degree classification scheme is by far the most complex proposed. Further, it requires very extensive laboratory analysies at many points during the waste managment cycle. The laboratory analyses prepared are considerably more extensive and therefore more costly than that required in any other scheme. Finally, the management operation proposed would also require considerable personnel and would be expensive.

Finally, the hazard values proposed or assigned to various waste characteristics in spite of the laboratory analyses and prescribed management operations cannot be readily justified.

8.2.4 Proposed Scheme #4

This classification scheme categorizes degree of hazard into three major categories on the basis of toxicity, reactivity and corrosivity levels. The classification is based on intrinsic hazard only and does not consider exposure in defining hazard levels.

The proposed scheme is deficient in several other aspects. The justification and rationale are not clear for the ranking of hazardous characteristics into each of the hazard levels. The classification is not complete. For example, wastes with toxicity greater than $LD_{50} \angle 5$ mg/kg are not included. Likewise carcinogenic and mutagenic wastes are not discussed. Such important waste characteristics as persistance and biaccumulativity are not considered.

Management requirements presented are very general and vague. Finally, this scheme does present quantity exclusion in a more comprehensive manner and to a greater extent than any other scheme. Unfortunately, there is no rigorous justification presented for the quantity exclusion limits suggested.

8.2.5 Proposed Scheme #5

This scheme has the benefit of greater simplicity than many others because it has only two levels of hazard. It is relatively comprehensive in terms of characteristics and properties included in ranking. However, it has the following shortcomings. The scheme does not provide justification or rationale for characteristics included in the various hazard levels or for the limits within characteristics chosen to define those levels. There is no suggestion of how management requirements would differ for the two tiers, or how the hazard ranking would otherwise be used. The scheme is based on intrinsic hazard only, and does not consider exposure in assigning hazard levels.

8.2.6 Proposed Scheme #6

This scheme proposes three categories for hazardous wastes but is deficient in numerous important aspects. The scheme appears to address only "toxic wastes" and completely ignores ignitable, corrosive, reactive, radioactive and infectious wastes. The system considers land disposal only and does not specify how the technical requirements of the three different types of landfills would differ. The system considers intrinsic hazard only.

8.2.7 Proposed Scheme #7

This scheme is too vague to be considered in that all of the waste characteristics and therefore hazard degree categories are described in qualitative terms only such as highly toxic wastes, moderately toxic wastes and related substances.

8.2.8 Proposed Scheme #8

This scheme proposed a degree of hazard classification based on multiple extractions. The scheme suggested is too vague to define the various categories because it fails to define ignitability, reactivity, corrosivity, and those wastes which are hazardous due to biological testing? There are no limits suggested and/or test methods to identify these wastes in terms of the environmental protection provided.

8.2.9 Proposed Scheme #9

This scheme proposes three hazard categories but is very general and describes hazard characteristics in qualitative and general terms. For example, the following characteristics on which hazard degree categories would be classified are included in this scheme: "present a constant hazard to health or the environment"; "cannot be safely released into the environment in any significant quantities"; "present a constant hazard to health or environment, but do not require extreme care in storage, handling, and transporting. . ."; and, "present no hazard to health or the environment when handled in a controlled manner during storage, handling, and transporting.") There are no limits suggested and/or test methods to define which wastes would belong in each class.

Further, the distinctions between the managment methods suggested for each class are vague and insufficient. For example, what would constitute a "properly designated landfill" for Class II or "less stringent design criteria" for Class III.

8.2.10 Proposed Scheme #10

This scheme proposes three hazard degree categories but again is too vague. For example, the following hazard criteria are suggested in this scheme: "wastes which present a severe, imminent danger to the environment and public health and which will require the utmost care during all stages of handling. . .", "wastes which pose a possible danger to the environment or public health if disposed of . . ." and "wastes for which data indicate that potential hazards are relatively low. . .")

There are no limits suggested and/or test methods to define which wastes would belong in each class.

The scheme provides no technical or rationale justification for the system suggested (i.e., why are highly toxic pesticides more of a concern than organic solvents which may be carcinogens?) there is no indication of the differences in management practices which would be applied to each class.

8.2.11 Proposed Scheme #11

This scheme suggests that the degree of care provided to a hazardous waste must be commensurate with its degree of hazard. More specifically, this scheme proposed that the following matrix rating system be utilized: Hazardous waste facilities should be related on the basis of containment ability rather than require all such facilities to meet given design and operation requirements. In similar fashion, waste materials would be ranked on the basis of the particular hazards, and degree of hazard posed by the waste. Thus, for example, containment facilities having a low rating could accept only waste materials having a low hazard potential and requiring low containment.

The approach suggested by this scheme is similar to the class of hazard distinctions the Environmental Protection AGency has made in the Phase I regulations in that it focuses on waste properties (although it also includes degree of hazard).

8.2.12 Proposed Scheme #12

This scheme proposes a total of five hazard degree categories. Unfortunately the scheme suggested is too vague, and does not provide a technical description of the various classes of hazard. Again the hazard degree categories are described in vague terms such as ". . . represent a grave risk to human health or the environment through toxicity . . .", ". . . pose a substantial risk to health and/or the environment through improper handling, transfer or storage . . .", ". . . that they are body-threatening, rather than life threatening and as such . . ."

There are no limits suggested and/or test methods to identify the different levels of human health impacts suggested, or the procedure for determining which wastes present each level of harm.

The scheme provides no technical justification or rationale for including (in general concept) only toxic wastes in the "extremely hazardous" and "hazardous" waste class (i.e., why are toxic wastes more of a concern than explosive wastes or highly flammable wastes?). The differences in management requirements that would be associated with each hazard level are only referred to in general (conceptual) terms.

Finally, the hazard ranking is based on intrinsic hazard only, and does not include exposure considerations.

8.2.13 State of California Scheme

State of California is using a hazard degree categorization scheme which contains two hazard degree categories classified according to pertinent characteristics of wastes (i.e., toxicity, carcinogens, flammable, reactive wastes, etc.)

The degree of hazard system described above has worked relatively successfully in California. However, from the standpoint of a national regualtion, the Environmental Protection Agency sees the following shortcomings of the scheme: (1) EPA is not aware of the technical justification for the ranking of the hazard classes or the limits within a characteristic for placing wastes in different hazard classes; (2) all hazardous wastes defined by California, both hazardous and extremely hazardous, are taken to the same disposal facilities (Class I). The only difference in managment requirements is in administrative and handling requirements. The Agency does not believe such limited differences justify a complicated National degree of hazard system. (3) The definition of hazardous waste in California is different from that in the final EPA regulations. The hazardous wastes and substances used in listing hazardous wastes and structuring the degree of hazard system would not be applicable to EPA's hazardous waste definition without substantial modification."

8.2.14 State of Texas Scheme

State of Texas hazard degree categorization scheme contains three hazard categories determined using Texas degree of hazard index. While this degree of hazard index is relatively comprehensive and well designed, it does not include some important waste characteristics (such as carcinogenicity) and is designed solely for land disposal.

The Environmental Protection Agency sees two additional problems in applying the State of Texas scheme on national laws. "(1) Hazardous wastes, as defined by EPA all appear to be in one class in Texas. The purpose of Texas degree of hazard system seems to be to distinguish between all hazardous wastes and two different classes of nonhazardous wastes. Thus, it does not appear to be applicable to determination of hazard levels among hazardous wastes;

(2) In the Texas system, wastes are sent to the State for analysis and ranking. This is not feasible on a national level and is inconsistent with the approach to determination of hazard in the subtitle C regulations."

8.2.15 State of Washington Scheme

The degree of hazard scheme for toxic wastes used by Washington State is based on a categorization scheme utilizing both aquatic toxicity (LC_{50}) and oral toxicity (LD_{50}). Because this scheme is very similar to that in proposed scheme #2, the problems discussed under proposed scheme #2 apply here also.

8.2.16 State of Rhode Island Scheme

The State of Rhode Island degree of hazard scheme is one of the most comprehensive and detailed systems designed. The major problem according to the Environmental Protection AGency is that no technical justification for the limits within characteristics and the ranking of characteristics used to define various degrees of hazard within a class are provided. Furthermore, relating management standards to this complex hierarchy is, in the Agency's view, impractical. The Environmental Protection Agency's comments on this scheme are as follows: "In requesting additional information from the State on this degree of hazard system, especially with respect to the technical justification for the various levels established, the commenter responded as follows:

> '. . . The standards established in these rules and regulations (Rhode Island) are arrived at by this Department with significant input from a 'Hazardous Waste Task Force' appointed by the Director of the Department and representing industrial, conservation, and government interests in our community. Therefore, these regulations represent, for the most part, agreed upon level of standards which are acceptable to many interests . . . The toxicity levels established for defining Types 1A, 1B and 1C were originally proposed by the industrial representation on our task force and were based, I understand, from findings by this industry that these levels were, for the most part, acceptable to other federal agencies such as the Consumer Product Safety Commission . . .'

The commenter, however, failed to provide any actual technical justification as requested by EPA. This type of concensus rulemaking with industry cannot be carried out at the Federal level.

8.3 CONCLUSIONS

A number of conclusions can be readily made from the information presented in the previous sections of this report.

First, a number of hazard degree categorization schemes proposed to the Environmental Protection Agency are vague,even crude,and propose to undertake hazard degree categorization based on essentially qualitative assessment of hazards. Obviously, these cannot be used for hazard degree categorizations.

Conversely, there is indeed a number of hazard degree categorization schemes either proposed or enacted by States which are well thoughtout and comprehensive and can be used to categorize wastes by degree of hazards.

For the most part the hazard degree in each of these is based on certain chemical and physical properties of wastes. The most fequently used of these properties include toxicity, corrosivity, reactivity and ignitability. Several other waste characteristics have been advanced as important in setting degree of hazard categories, such as bioconcentration and persistence.

Further, a significant number of schemes propose, in addition to hazard degree categorization, special hazardous waste lists which include unique wastes. Most of these include carcinogenic wastes and wastes with microorganisms, and/or low hazard wastes generated in large quantities.

While a significant number of schemes consider the intrinsic hazard of wastes as well as the exposure hazard, there are waste categorization schemes that emphasize only intrinsic hazard.

In summary, while there are numerous schemes that are inadequate for hazard degree categorization, the schemes of CMA, Proposed Schemes 4 and 5, and the four States of California, Texas, Washington and Rhode Island appear to be comprehensive and well designed.

FIGURE 1

WASTE GENERATION AND CONTROL LEVEL

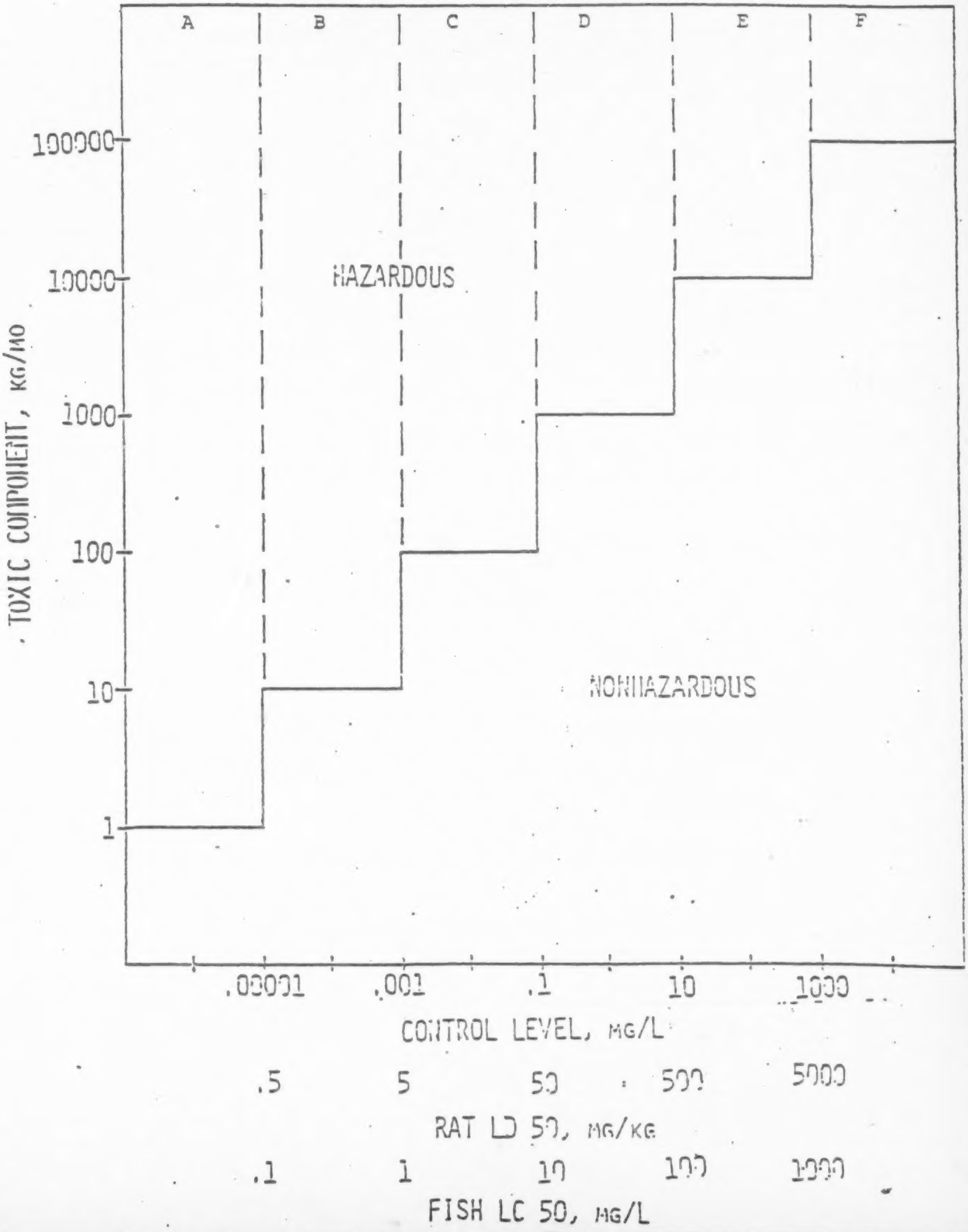


Figure 2

CLASSIFICATION OF SOLID WASTES BY TOXICITY

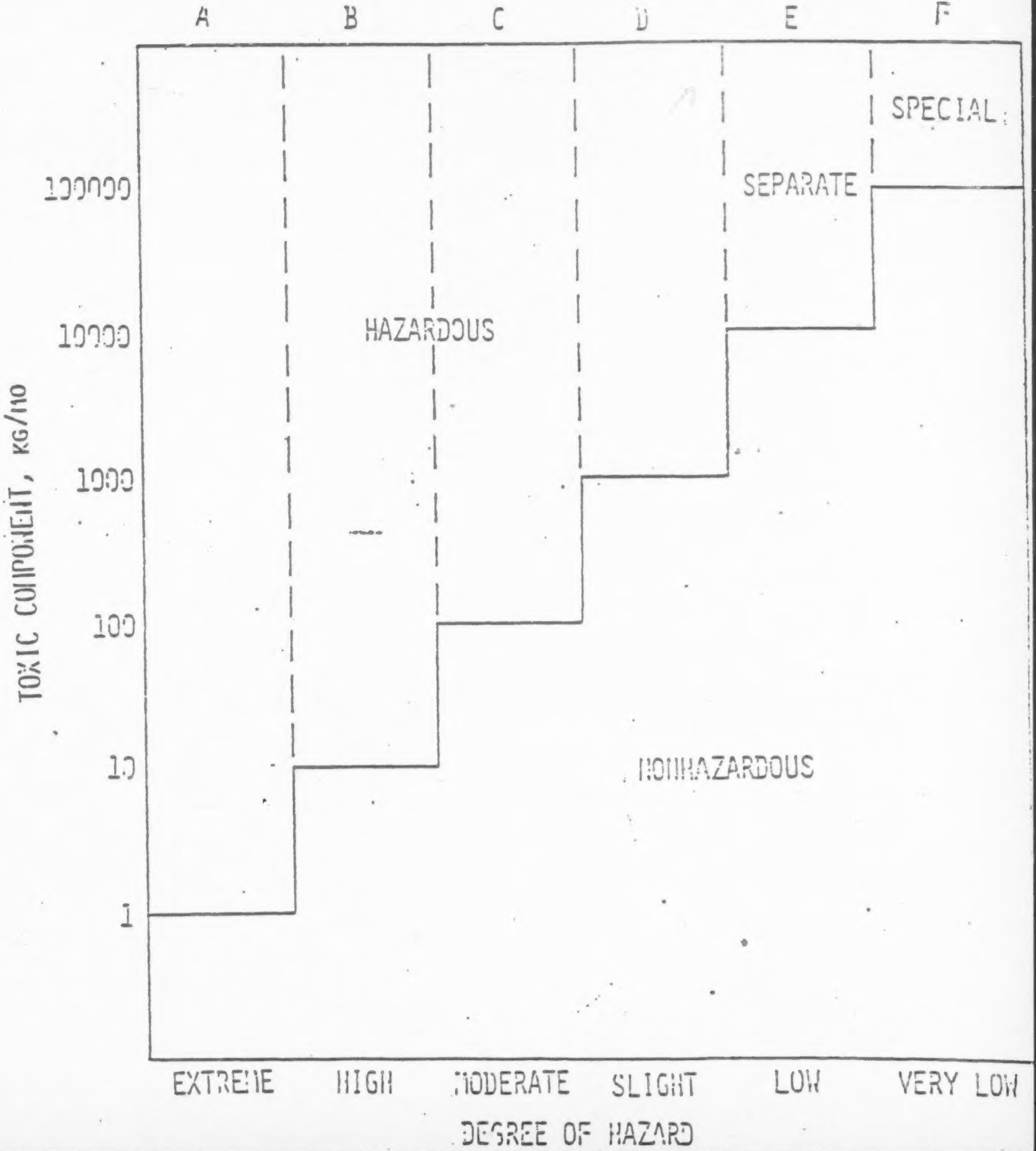


FIGURE 3

ILLUSTRATIVE CHARACTERISTICS TO BE TAKEN INTO ACCOUNT IN A HAZARDOUS WASTE TREATMENT/DISPOSAL CLASSIFICATION SYSTEM

I. Hazard Factors

  A. Potential for Human Harm

    1. Ingestion Hazard

    2. Inhalation Hazard

  B. Potential for Environmental Harm

    1. Toxicity to Fish

II. Hazard Modification Factors

  A. Bioaccumulation

  B. Biodegradation

    1. Aerobic

    2. Anaerobic

  C. Potential for Transfer

    1. Adsorption to Soil

    2. Water Solubility

    3. Volatility

III. Applicability of Incineration

  A. Under Best Available Conditions (equivalent to T=1200°C, R.T.=2 seconds and 3% excess oxygen)

  B. Under Conditions Typical for Refuse Incineration and Boilers

IV. Handling Properties

  A. Ignitability

  B. Corrosivity

  C. Reactivity

FIGURE 4

ILLUSTRATIVE HAZARD VALUES AND OTHER PROPERTIES FOR VARIOUS WASTE CHARACTERISTICS

Potential for Human and/or Environmental Harm			
A. Human			
1. Ingestion Hazard	a) Below Minimum		0
	b) Minimum to Moderate	(Criteria would be established for each hazard, hazard reduction, and hazard control range of each waste characteristic.	+1
	c) Moderate to Severe		+2
2. Inhalation Hazard	a) Below Minimum		0
	b) Minimum to Moderate		+1
	c) Moderate to Severe		+2
B. Environmental			
1. Toxicity to Fish	a) Below Minimum		0
	b) Minimum to Moderate		+1
	c) Moderate to Severe		+2
Hazard Modification Factors			
A. Bioaccumulation			
1. Below Minimum			0
2. Minimum to Moderate			+1
3. Moderate to Severe			+2
B. Biodegradation			
1. Aerobic Conditions	a) No Effect		0
	b) Moderate		-1
	c) Extensive		-2
2. Anaerobic Conditions	a) No Effect		0
	b) Moderate		-1
	c) Extensive		-2
C. Transfer Potential			
1. Soil Adsorption	a) Low		0
	b) Moderate		-1
	c) Extensive		-2
2. Water Solubility	a) Moderate		0
	b) Low		-1
3. Volatility	a) High		+1
	b) Moderate		0
	c) Low		-1

FIGURE 4 (Continued)

ILLUSTRATIVE HAZARD VALUES AND OTHER PROPERTIES FOR VARIOUS WASTE CHARACTERISTICS

Waste Characteristics	Hazard, Hazard Reduction and Hazard Control Criteria	Hazard Value	Incineration Properties	Handling Propertie
II. Applicability of Incineration				
a) Unacceptable			a	
b) Best Available Conditions			b	
c) Refuse Conditions			c	
V. Handling Properties				
A. Ignitability				
1. Below Minimum				a
2. Minimum to Moderate				b
3. Moderate to Severe				c
B. Corrosivity				
1. Below Minimum				a
2. Minimum to Moderate				b
3. Moderate to Severe				c
C. Reactivity				
1. Below Minimum				a
2. Minimum to Moderate				b
3. Moderate to Severe				c

FIGURE 5

TREATMENT/DISPOSAL FACILITY DESCRIPTION AND SYMBOL DESIGNATION

Description	Designation
Incineration at T=1200°C, R.T. = 2 seconds residence, and 3% excess oxygen, or at specific combustion efficiency (Best Available)	I_{BA}
Incineration meeting Clean Air Act emission standards for garbage and refuse or power generation	I_R
Landfill with best available leacheate control per Section 250.45-2	L_{BA}
Landfill at sites where groundwater pollution potential is minimal because of absence of groundwater, remoteness of potential surfacing; absence of usable groundwater, etc.	L_{NG}
Landfill per standards for municipal garbage and refuse, Section 3008 regulations	L_R
Landfarming	L_F

FIGURE 6

ILLUSTRATIVE MINIMUM REPORTABLE QUANTITIES FOR DIFFERENT HAZARD VALUES

Hazard Value	Potential for Human and/or Environmental Harm-Subtotal Hazard Value	Reportable Quantity* (Pounds)
at least one 2	5 - 6	a
	3 - 4	b
	2	c
no 2's	3	d
	2	e
	1	f

* $a < b < c < d < e < f$

FIGURE 7

ILLUSTRATIVE FORMAT FOR LISTING HAZARDOUS WASTE CHARACTERISTICS

WASTE MATERIAL		
Hazard Values	Ingestion	
	Inhalation	
	Toxicity to Fish	
	Subtotal	
	Reportable Quantity	
Hazard Modification Values	Bioaccumulation	
	Aerobic Biodegradation	
	Anaerobic Biodegradation	
	Adsorption	
	Water Solubility	
	Volatility	
	Subtotal	
	Net Hazard Value	
	Incineration Properties	
	Approved Treatment and Disposal Methods	
Handling Proper	Ignitability	
	Corrosivity	
	Reactivity	

FIGURE 8

WASTE CLASSIFICATION AND TREATMENT/DISPOSAL DECISION TREE - PART 1

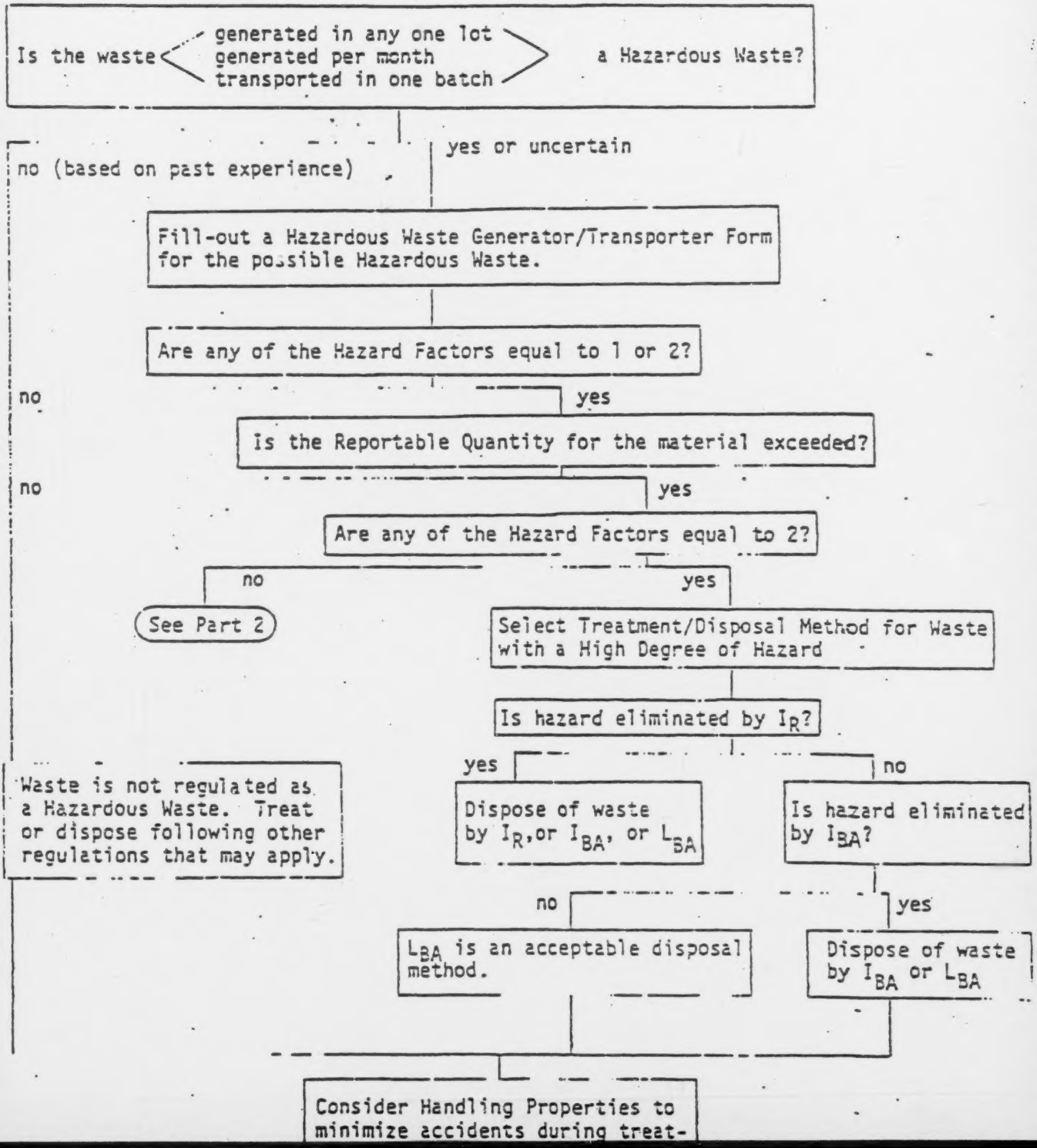
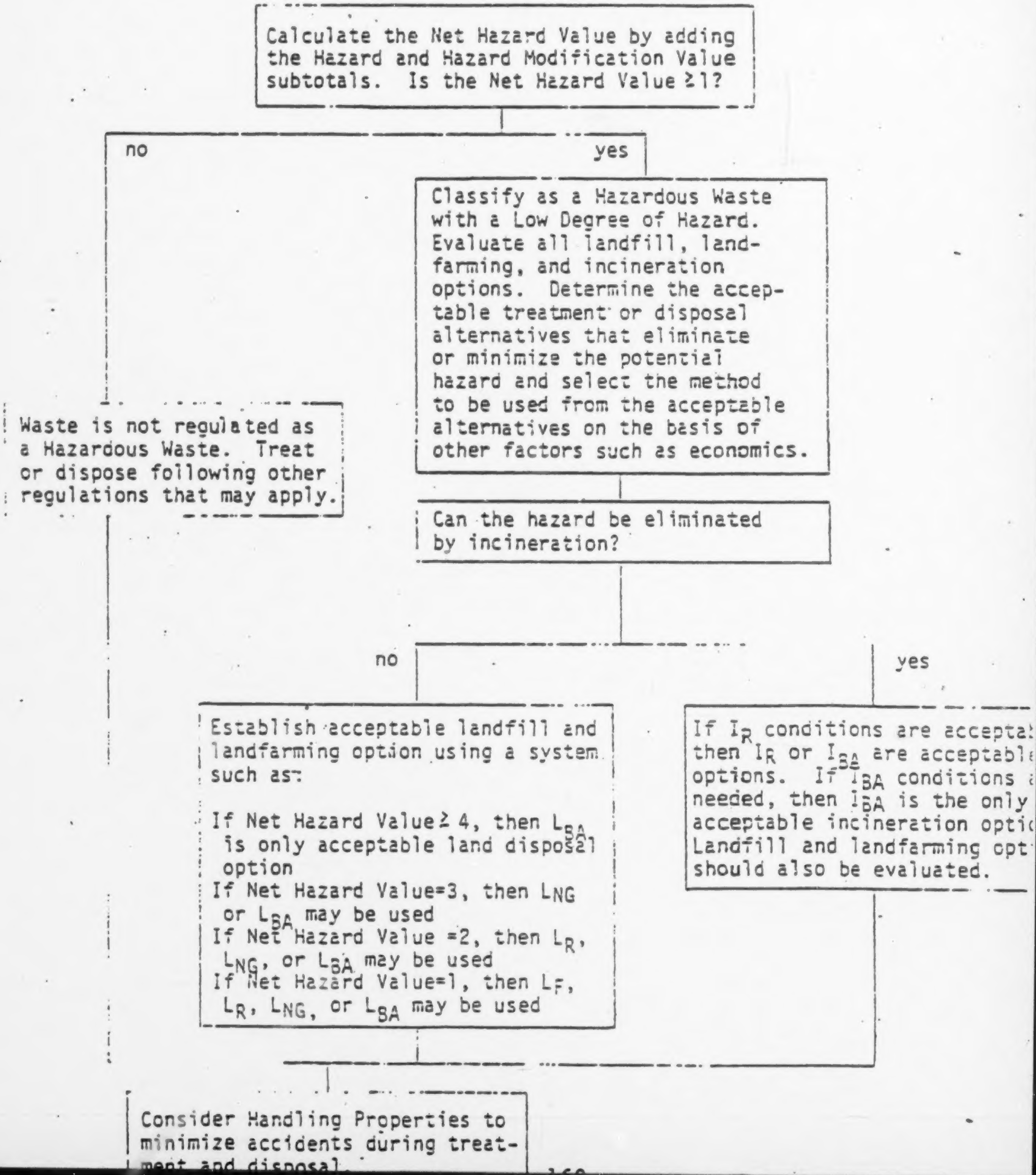

Is the waste
generated in any one lot
generated per month
transported in one batch
a Hazardous Waste?
no (based on past experience)
yes or uncertain
Fill-out a Hazardous Waste Generator/Transporter Form for the possible Hazardous Waste.
Are any of the Hazard Factors equal to 1 or 2?
no
yes
Is the Reportable Quantity for the material exceeded?
no
yes
Are any of the Hazard Factors equal to 2?
no
yes
See Part 2
Select Treatment/Disposal Method for Waste with a High Degree of Hazard
Is hazard eliminated by I_R?
yes
no
Waste is not regulated as a Hazardous Waste. Treat or dispose following other regulations that may apply.
Dispose of waste by I_R, or I_{BA}, or L_{BA}
Is hazard eliminated by I_{BA}?
no
yes
L_{BA} is an acceptable disposal method.
Dispose of waste by I_{BA} or L_{BA}
Consider Handling Properties to minimize accidents during treat-

FIGURE 9

WASTE CLASSIFICATION AND TREATMENT/DISPOSAL DECISION TREE - PART 2



Calculate the Net Hazard Value by adding the Hazard and Hazard Modification Value subtotals. Is the Net Hazard Value ≥ 1?

Classify as a Hazardous Waste with a Low Degree of Hazard. Evaluate all landfill, landfarming, and incineration options. Determine the acceptable treatment or disposal alternatives that eliminate or minimize the potential hazard and select the method to be used from the acceptable alternatives on the basis of other factors such as economics.

Waste is not regulated as a Hazardous Waste. Treat or dispose following other regulations that may apply.

Can the hazard be eliminated by incineration?

Establish acceptable landfill and landfarming option using a system such as:

If Net Hazard Value ≥ 4, then L_{BA} is only acceptable land disposal option
If Net Hazard Value=3, then L_{NG} or L_{BA} may be used
If Net Hazard Value =2, then L_R, L_{NG}, or L_{BA} may be used
If Net Hazard Value=1, then L_F, L_R, L_{NG}, or L_{BA} may be used

If I_R conditions are accepta
then I_R or I_{BA} are acceptabl
options. If I_{BA} conditions a
needed, then I_{BA} is the only
acceptable incineration optic
Landfill and landfarming opt
should also be evaluated.

Consider Handling Properties to minimize accidents during treatment and disposal.

FIGURE 10

ILLUSTRATIVE HAZARDOUS WASTE CLASSIFICATION AND TREATMENT/DISPOSAL FORM

Generator/Transporter ______________________________

Waste ______________________________

Possible Hazardous Constituent ______________________________

A. Enter the appropriate values from a listing of Hazardous Waste Characteristics or after conducting suitable tests, etc.

		Waste		Hazardous Constituent	
		Result from List or Testing	Hazard Value	Result from List or Testing	Hazard Value
Hazard Factors	Ingestion				
	Inhalation				
	Fish Toxicity				
	Sub-total				
Reportable Quantity	Reportable Quantity				
	Amount in Waste-Estimated				
	- Actual				

If any of the Hazard Values = 1 or 2, and the Reportable Quantity is exceeded go to B.

If none of the Hazard Values = 1 or 2, or the Reportable Quantity is not exceeded, go to H.

B. Incineration Properties

I_R acceptable

I_{BA} acceptable

Unacceptable

C. If any of the Hazard Values = 2, go to D.

If none of the Hazard Values = 2, go to E.

D. Classify as a waste with a High Degree of Hazard (Step 1).

If incineration is acceptable, I_R should be considered. If I_R is acceptable the choice between I_{BA} and I_R depends on hazard elimination, economics, etc. If I_R is unacceptable, I_{BA} should be considered.

If incineration is not acceptable, L_{BA} should be selected.

Go to J.

Page 1 of 3

Figure 10 (Continued)

ILLUSTRATIVE HAZARDOUS WASTE CLASSIFICATION
AND TREATMENT/DISPOSAL FORM

	Waste		Hazardous Constituent	
E. Hazard Modification Factors	Result from List or Testing	Hazard Value	Result from List or Testing	Hazard Value
Bioaccumulation				
Biodegradation				
- Aerobic				
- Anaerobic				
Transfer Properties				
- Soil Adsorption				
- Water Solubility				
- Volatility				
Sub-total				
Net Hazard Value				

The Net Hazard Value = the total of the Hazard Factor and Hazard Modification Factor sub-totals.

If the Net Hazard Value ≥ 1, go to F.

Classify as a waste with a Low Degree of Hazard (Step 1).

Consider all of the incineration, landfill and landfarming options making the selection based on hazard elimination, economics, etc.

Go to G.

G. If I_{BA} is needed, then I_{BA} is a possible selection.

If I_R is acceptable, then I_R or I_{BA} are possible options.

If Net Hazard Value ≥4, then L_{BA} is a possible selection.
=3, then L_{NG} or L_{BA} are possible selections.
=2, then L_R, L_{NG} or L_{BA} are possible selections.
=1, then L_F, L_R, L_{NG} or L_{BA} are possible selections.

H. Waste is not regarded as a Hazardous Waste.

Go to I.

I. Waste Classification

High Degree of Hazard: ____ Go to J.
Low Degree of Hazard: ____
Not a Hazardous Waste: ____ Go to K.

Figure 10 (Continued)

ILLUSTRATIVE HAZARDOUS WASTE CLASSIFICATION AND TREATMENT/ DISPOSAL FORM

J. The Hazardous Waste Treatment/Disposal Method selected is:

I_{BA} ____
I_{R} ____
L_{BA} ____
L_{NG} ____
L_{R} ____
L_{F} ____

Basis for Selection:

Go to K.

K. Handling Properties

	Waste		Hazardous Constituent	
	Result from List or Testing	Hazard Value	Result from List or Testing	Hazard Value
Ignitability				
Corrosivity				
Reactivity				

Page 3 of 3

FIGURE 11

GRAPHIC REPRESENTATION OF THE HAZARDOUS WASTE DECISION MODEL

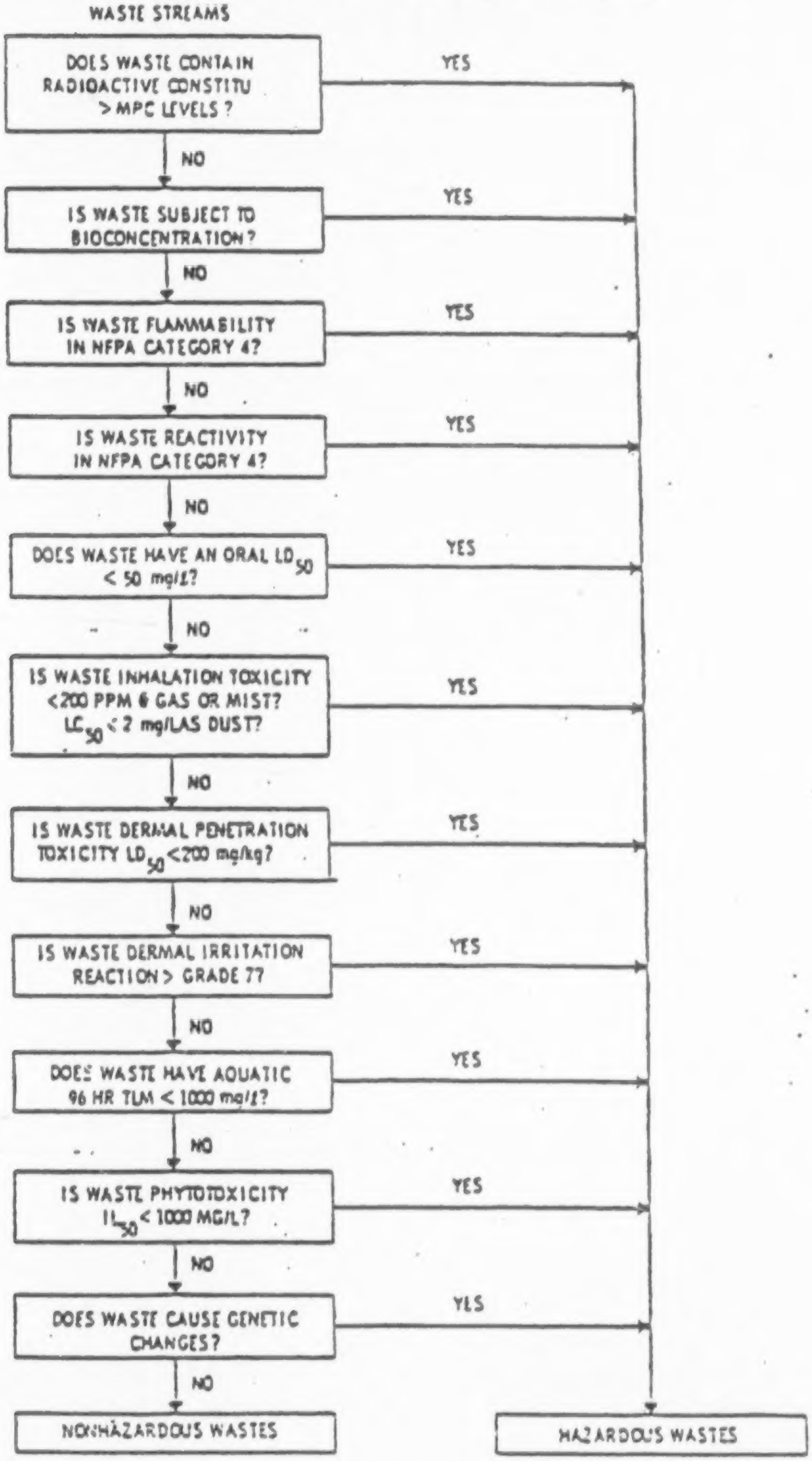

WASTE STREAMS
DOES WASTE CONTAIN RADIOACTIVE CONSTITU >MPC LEVELS ?
YES
NO
IS WASTE SUBJECT TO BIOCONCENTRATION?
YES
NO
IS WASTE FLAMMABILITY IN NFPA CATEGORY 4?
YES
NO
IS WASTE REACTIVITY IN NFPA CATEGORY 4?
YES
NO
DOES WASTE HAVE AN ORAL LD_{50} < 50 mg/l?
YES
NO
IS WASTE INHALATION TOXICITY <200 PPM & GAS OR MIST? LC_{50} < 2 mg/LAS DUST?
YES
NO
IS WASTE DERMAL PENETRATION TOXICITY LD_{50} <200 mg/kg?
YES
NO
IS WASTE DERMAL IRRITATION REACTION > GRADE 7?
YES
NO
DOES WASTE HAVE AQUATIC 96 HR TLM < 1000 mg/l?
YES
NO
IS WASTE PHYTOTOXICITY IL_{50} < 1000 MG/L?
YES
NO
DOES WASTE CAUSE GENETIC CHANGES?
YES
NO
NONHAZARDOUS WASTES
HAZARDOUS WASTES

TABLE 1

ESTIMATED RESEARCH EXPENDITURES ON HAZARDOUS WASTES BY THE OFFICE OF RESEARCH AND DEVELOPMENT (ORD), EPA*

Research Activity**	Research Expenditures ($ Million)		
	FY 78	FY 79	FY 80
Sampling & Analytical Procedures	$ 0.1	$ 0.7	$ 0.7
Toxicity Assessment and Health Effects of Hazardous Wastes	0.2	0.2	0
Fate & Transport of Hazardous Wastes	0.5	0.5	0.5
Technologies for Clean-up of Existing Sites	0	0.5	0.8
Technologies for Managing Current & Future Waste Streams	2.4	3.4	3.4
Socio-economic Aspects of Facility Siting	0	0	0
Total ORD Expenditures on Hazardous Waste Research	$ 3.2	$ 5.3	$ 5.4
Total ORD Expenditures on Hazardous Municipal Waste Research ***	$ 6.6	$ 7.9	$ 8.1

Source: Informal Communication from Office of Research & Development, September 5, 1979.

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* These figures include funds received by ORD from the Office of Solid Waste (OSW) to conduct special projects on hazardous wastes for OSW. These funds amount to approximately $0.5 million in FY78 and $1.0 million in FY79.

** The categories of research activity correspond to the R&D recommendations made in pages 10-12 of this report.

*** Includes research on municipal wastes, resource recovery, and high volume mining wastes.

TABLE 2

NONRADIOACTIVE HIGH-HAZARD COMPOUNDS

Miscellaneous Inorganics

Ammonium Chromate
Ammonium Dichromate
Antimony Pentafluoride
Antimony Trifluoride
Arsenic Trichloride
Arsenic Trioxide
Cadmium (alloys)
Cadmium Chloride
Cadmium Cyanide
Cadmium Nitrate
Cadmium Oxide
Cadmium Phosphate
Cadmium Potassium Cyanide
Cadmium (powdered)
Cadmium Sulfate
Calcium Arsenate
Calcium Arsenite
Calcium Cyanides
Chromic Acid
Copper Arsenate
Copper Cyanides
Cyanide (ion)
Decaborane
Diborane
Hexabor
Hydrazine
Hydrazine Azide
Lead Arsenate
Lead Arsenite
Lead Azide
Lead Cyanide
Magnesium Arsenite
Manganese Arsenate
Mercuric Chloride
Mercuric Cyanide
Mercuric Diammonium Chloride
Mercuric Nitrate
Mercuric Sulfate
Mercury
Nickel Carbonyl
Nickel Cyanide
Pentaborane-9
Pentaborane-11
Perchloric Acid (to 72%)
Phosgene (carbonyl chloride)
Potassium Arsenite
Potassium Chromate
Potassium Cyanide
Potassium Dichromate
Selenium
Silver Azide
Silver Cyanide
Sodium Arsenate
Sodium Arsenite
Sodium Bichromate
Sodium Chromate
Sodium Cyanide

TABLE 2 (continued)
NONRADIOACTIVE HIGH-HAZARD COMPOUNDS

Sodium Monogluoroacetate

Tetraborane

Thallium Compounds

Zinc Arsenate

Zinc Arsenite

Zinc Cyanide

Halogens and Interhalogens

Bromine Pentafluoride

Chlorine

Chlorine Pentafluoride

Chlorine Trifluoride

Fluorine

Perchloryl Fluoride

Miscellaneous Organics

Arolein

Alklyl Leads

Carcinogens (in general)

Chloropicrin

Copper Acetylide

Copper Chlorotetrazole

Cyanuric Triazide

Diazodinitrophenol (DDNP)

Dimethyl Sulfate

Dinitrobenzene

Dinitro Cresols

Dinitrophenol

Dinitrotoluene

Dipentaerythritol hexanitrate (DPEHN)

GB (propoxy (2)-methylphosphoryl fluoride)

Gelatinized Nitrocellulose (PNC)

Glycol Dinitrate

Gold Fulminate

Lead 2,4-dinitrocresorcinate (LDNR)

Lead Styphnate

Lewisite (2-chloroethenyl dichloroarsine)

Mannitol Hexanitrate

Nitroaniline

Nitrocellulose

Nitrogen Mustards 2,2',2" (trichlorotriethylamine)

Nitroglycerin

Organic Mercury Compounds

Pentachlorophenol

Picric Acid

Potassium Dinitrobenzfuroxan (KDNBF)

Silver Acetylide

Silver Tetrazene

Tear Gas (CN) (chloroacetophenone)

Tear Gas (CS) (2-chlorobenzylidene malononitrile)

Tetrazene

VX (ethoxy-methyl phosphoryl N,N dipropoxy-(2,2), thiocholine)

TABLE 2 (Continued)

NONRADIOACTIVE HIGH-HAZARD COMPOUNDS

Organic Halogen Compounds

Aldrin
Chlorinated Aromatics
Chlordane
Copper Acetoarsenite
2,4-D (2,4-dichlorophenoxyacetic acid)
DDD
DDT
Demeton
Dieldrin
Endrin
Ethylene Bromide
Fluorides (organic)
Guthion
Heptachlor
Lindane
Methyl Bromide
Methyl Chloride
Methyl Parathion
Parathion
Polychlorinated Biphenyls (PCB)

Source: Office of Solid Waste Management Programs. "Report to Congress; Disposal of Hazardous Wastes," Environmental Protection Agency Publication No. SW-115 (Washington, D.C.: U.S. Government Printing Office, 1974).

Page 3 of 3

TABLE 3

HAZARDOUS WASTE FROM NONSPECIFIC SOURCES

Industry and EPA hazardous waste number	Hazardous Waste	Hazard Code
Generic:		
F001	The spent halogenated solvents used in degressing, tetrachloroethylene, trichloroethylene, methylene choloride, 1,1,1-trichloroethane, carbon tetrachloride, and the chlorinated fluorocarbons, and sludges from the recovery of these solvents in degreasing operations.	(T)
F002	The spent halogenated solvents, tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, o-dichlorobenzene, trichlorofluoromethane and the still bottoms from the recovery of these solvents	(T)
F003	The spent non-halogenated solvents, xylene, acetone, ethyl acetate, ethyl ether, n-butyl alcohol, cyclohexanone, and the still bottoms from the recovery of these solvents	(I)
F004	The spent non-halogenated solvents, cresols and cresylic acid, nitrobenzene, and the still bottoms from the recovery of these solvents	(T)
F005	The spen non-halogenated solvents, methanol toluene, methyl ethyl ketone, methyl isobutyl ketone, carbon disulfide, isobutanol, pyridine and the still bottoms from the recovery of these solvents	(I,T)
F006	Wastewater treatment sludges from the electroplating operations	(T)
F007	Spent plating bath solutions from electroplating operations	(R,T)
F008	Plating bath sludges from the bottom of plating baths from electroplating operations	(R,T)

TABLE 3 (Continued)

HAZARDOUS WASTE FROM NONSPECIFIC SOURCES

F009	Spent stripping and cleaning bath solutions from electroplating operations	(R,T)
F010	Quenching bath sludge from oil baths from metal heat treating operations	(R,T)
F011	Spent solutions from salt bath pot cleaning from metal heat treating operations	(R,T)
F012	Quenching wastewater treatment sludges from metal heat treating operations	(T)
F013	Flotation tailings from selective flotation from mineral metals recovery operations	(T)
F014	Cyanidation wastewater treatment tailing pond sediment from mineral metals recovery operations	(T)
F015	Spent cyanide bath solutions from mineral metals recovery operations	(R,T)
F016	Dewatered air pollution control scrubber sludges from coke ovens and blast furnaces	(T)

Page 2 of 2

TABLE 4

HAZARDOUS WASTE FROM SPECIFIC SOURCES

Industry and EPA hazardous waste number	Hazardous Waste	Hazard Code
Wood Preservation:		
K001	Bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use cresote and/or pentachlorophenol	(T)
Inorganic Pigments:		
K002	Wastewater treatment sludge from the production of chrome yellow and orange pigments	(T)
K003	Wastewater treatment sludge from the production of molybdate orange pigments	(T)
K004	Wastewater treatment sludge from the production of zinc yellow pigments	(T)
K005	Wastewater treatment sludge from the production of chrome green pigments	(T)
K006	Wastewater treatment sludge from the production of chrome oxide green pigments (anhydrous and hydrated)	(T)
K007	Wastewater treatment sludge from the production of iron blue pigments	(T)
K008	Oven residue from the production of chrome oxide green pigments	(T)
Organic Chemicals:		
K009	Distillation bottoms from the production of acetaldehyde from ethylene	(T)
K010	Distillation side cuts from the production of acetaldehyde from ethylene	(T)
K011	Bottom stream from the wastewater stripper in the production of acylonitrile	(R,T)
K012	Still bottoms from the final purification of acylonitrile in the production of acylonitrile	(T)

TABLE 4 (Continued)

HAZARDOUS WASTE FROM SPECIFIC SOURCES

K013	Bottom stream from the acetonitrile column in the production of acytonitrile	(R,T)
K014	Bottoms from the acetronitrile purification column in the production of acylonitrile	(T)
K015	Still bottoms from the distillation of benzyl chloride	(T)
K016	Heavy ends or distillation residues from the production of carbon tetrachloride	(T)
K017	Heavy ends (still bottoms) from the purification column in the production of epichlorohydrin	(T)
K018	Heavy ends from fractionation in ethyl chloride production	(T)
K019	Heavy ends from the distillation of ethylene dichloride in ethylene dichloride production	(T)
K020	Heavy ends from the distillation of vinyl chloride in vinyl chloride monomer production	(T)
K021	Aqueous spent antimony catalyst waste from fluoromethanes production	(T)
K022	Distillation bottom tars from the production of phenol/acetone from cumene	(T)
K023	Distillation light ends from the production of phthalic anhydride from naphthalene	(T)
K024	Distillation bottoms from the production of phthalic anhydride from naphthalene	(T)

TABLE 4 (Continued)
HAZARDOUS WASTE FROM SPECIFIC SOURCES

K025	Distillation bottoms from the production of nitrobenzene by the nitration of benzene	(T)
K026	Stripping still tails from the production of methyl ethyl pyridines	(T)
K027	Centrifuge residue from toluene disocyanate production	(R,T)
K028	Spent catalyst from the hydrochlorinator reactor in the production of 1,1,1-trichloroethane	(T)
K029	Waste from the product stream stripper in the production of 1,1,1-trichloroethane	(T)
K030	Column bottoms or heavy ends from the combined production of trichloroethylene and perchloroethylene	(T)
Pesticides:		
K031	By-products salts generated in the production of MSMA and cacodylic acid	(T)
K032	Wastewater treatment sludge from the production of chlordane	(T)
K033	Wastewater and scrub water from the chlorination of cyclopentradiene in the production of chlordane	(T)
K034	Filter solids from the filtration of hexachlorocyclopentradiene in the production of chlordane	(T)
K035	Wastewater treatment sludges generated in the production of cresote	(T)
K036	Still bottom from toluene reclamation distillation in the production of disulfatan	(T)
K037	Wastewater treatment sludges from the production of disulfatan	(T)
K038	Wastewater from the washing and stripping of phorate production	(T)

TABLE 4 (Continued)
HAZARDOUS WASTE FROM SPECIFIC SOURCES

K039	Filter cake from the filtration of diethylphosphorodithoric acid in the production of phorate	(T)
K040	Wastewater treatment sludge from the production of phorate	(T)
K041	Wastewater treatment sludge from the production of toxaphene	(T)
K042	Heavy ends or distillation residues from the distillation of tetrachlorobenzene in the production of 2,4,5-T	(T)
K043	2,6-Dichlorophenol waste from the production of 2,4-D	(T)
Explosives:		
K044	Wastewater treatment sludges from the manufacturing and processing of explosives	(R)
K045	Spent carbon from the treatment of wastewater containing explosives	(R)
K046	Wastewater treatment sludges from the manufacturing formulation and loading of lead-based initiating compounds	(T)
K047	Pink/red water from TNT generators	(R)
Petroleum Refining:		
K048	Dissolved air flotation (DAF) from the petroleum refining industry	(T)
K049	Slop oil emulsion solids from the petroleum refining industry	(T)
K050	Heat exchanger bundle cleaning sludge from the petroleum refining industry	(T)
K051	API separator sludge from the petroleum refining industry	(T)
K052	Tank bottoms (leaded) from the petroleum refining industry	(T)

TABLE 4 (Continued)

HAZARDOUS WASTE FROM SPECIFIC SOURCES

Leather Tanning Finishing:

K053	Chrome (blue) trimmings generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chrome tan/retan/wet finish; retan/wet finish; no beamhouse; through-the-blue; and shearing.	(T)
K054	Chrome (blue) shavings generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chrome tan/retan/wet finish; no beamhouse; through-the-blue; and shearing.	(T)
K055	Buffing dust generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chorme tan/retan/wet finish; retan/wet finish; no beamhouse, and through-the-blue.	(T)
K056	Sewer screenings generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; har save/chrome tan/retan/wet finish; no beamhouse; through-the-blue; and shearing.	(T)
K057	Wastewater treatment sludges generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retain/wet finish; hair save/chrome tan/retan/wet finish; retan/wet finish; no beamhouse; through-the-blue and shearing.	(T)
K058	Wastewater treatment sludges generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chrome tan/retan/wet finish; and through-the-blue.	(T)
K059	Wastewater treatment sludges generated by the following subcategory of the leather tanning and finishing industry; hair save/non-chrome tan/retan/wet finish.	(R)

TABLE 4 (Continued)

HAZARDOUS WASTE FROM SPECIFIC SOURCES

Iron and Steel:		
K060	Ammonia still time sludge from coking operations	(T)
K061	Emission control dust/sludge from the electric furnace production of steel	(T)
K062	Spent pickle liquor from steel finishing operations	(C,T)
K063	Sludge from time treatment of spent pickle liquor from steel finishing operations	(T)
Primary Copper:		
K064	Acid plant blowdown slurry/sludge resulting from the thickening of blowdown slurry from primary copper production	(T)
Primary Lead:		
K065	Surface impoundment solids contained in and dredged from surface impoundments at primary lead smelting facilities	(T)
Primary Zinc:		
K065	Sludge from treatment of process wastewater and/or acid plant blowdown from primary zinc production	(T)
K067	Electrolytic anode slimes/sludges from primary zinc production	(T)
K068	Cadmium plant leach residue (iron oxide) from primary zinc production	(T)
Secondary Lead:		
K069	Emission control dust/sludge from secondary lead smelting	(T)

TABLE 5

DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF, CLASSIFIED AS HAZARDOUS WASTE, BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
	1080 see P058
	1081 see P057
	(Acetate)phenylmercury see P092
	Acetone cynahydrin see P069
P001	3-(alpha-Acetonylbenzyl)-4-hydroxycoumarin and salts
P002	1-Acetyl-2-thiourea
P003	Acrolein
	Agarin see P007
	Agrosan GN 5 see P092
	Aldicarb see P069
	Aldifen see P048
P004	Aldrin
	Algimycin see P092
P005	Allyl alcohol
P006	Aluminum phosphide (R)
	ALVIT see P037
	Aminoethylene see P054
P007	5-(Aminomethyl)-3-isoxazolol
P008	4-Aminopyridine
	Ammonium metavanadate see P119
P009	Ammonium picrate (R)
	ANTIMUCIN WDR see P092
	ANTURAT see P073
	AQUATHOL see P088
	ARETIT see P020
P010	Arsenic acid
P011	Arsenic pentoxide
P012	Arsenic trioxide
	Athrombin see P001
	AVITROL see P008
	Aziridene see P054
	AZOFOS see P061
	Azophas see P061
	BANTU see P072

TABLE 5 (continued)

DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF, CLASSIFIED AS HAZARDOUS WASTE, BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
P013	Barium cyanide
	BASENITE see P020
	BCME see P016
P014	Benzenethiol
	Benzoepin see P050
P015	Beryllium dust
P016	Bis(chloromethyl)ether
	BLADAN-M see P071
P017	Bromoacetone
P018	Brucine
P019	2-Butanone peroxide
	BUFEN see P092
	Butaphene see P020
P020	2-sec-Butyl-4,6-dinitrophenol
P021	Calcium cyanide
	CALDON see P020
P022	Carbon disulfide
	CERSAN see P092
	CERESAN UNIVERSAL see P092
	CHEMOX GENERAL See P020
	CHEMOX P.E. see P020
	CHEM-TOL see P090
P023	Chloroacetaldehyde
P024	p-Chloroaniline
P025	1-(p-Chlorobenzoyl)-5-methoxy-2-methylindole-3-acetic acid
P026	1-(o-Chlorophenyl)thiourea
P027	3-Chloropropionitrile
P028	alpha-Chlorotoluene
P029	Copper cyanide
	CRETOX see P108
	Coumadin see P001
	Coumaten see P001
P030	Cyanides
P031	Cyanogen

TABLE 5 (continued)

DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF, CLASSIFIED AS HAZARDOUS WASTE, BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
P032	Cyanogen bromide
P033	Cyanogen chloride
	Cyclodan see P050
P034	2-Cyclohexyl-4,6-dinitrophenol
	D-CON see P001
	DETHMOR see P001
	DETHNEL see P001
	DFP see P043
P035	2,4-Dichlorophenoxyacetic acid (2,4-D)
P036	Dichlorophenylarsine
	Dicyanogen see P031
P037	Dieldrin
	DIELDREX see P037
P038	Diethylarsine
P039	0,0-Diethyl-S-(2-(ethylthio)ethyl)ester of phosphorothioci acid
P040	0,0-Diethyl-0-(2-pyrazinyl)phosphorothioate
P041	0,0-Diethyl phosphoric acid, 0-p-nitrophenyl ester
P042	2,4-Dihydroxy-alpha-(methylamino)-methyl benzyl alcohol
P043	Di-isopropytfluorophosphate
	DIMETATE see P044
	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro endo, endo see P060
P044	Dimethoate
P045	3,3-Dimethyl-1-(methylthio)-2-butanone-O-(methylamino)carbonyl)oxime
P046	alpha, alpha-Dimethylphenethylamine
	Dinitrocyclohexylphenol see P034
P047	4,6-Dinitro-o-cresol and salts
P048	2,4-Dinitrophenol
	DINOSEB see P020
	DINOSEBE see P020
	Disulfoton see P039
P049	2,4-Dithiobiuret
	DNBP see P020
	DOLCO MOUSE CEREAL see P108

TABLE 5 (continued)

DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF, CLASSIFIED AS HAZARDOUS WASTE, BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
	DOW GENERAL see P020
	DOW GENERAL WEED KILLER see P020
	DOW SELECTIVE WEED KILLER see P020
	DOWICIDE G see P090
	DYANACIDE see P092
	EASTERN STATES DUCCIDE see P001
	ELGETOL SEE P020
P050	Endosulfan
P051	Endrin
	Epinephrine see P042
P052	Ethylcyanide
P053	Ethylenediamine
P054	Ethyleneimine
	FASCO FASCRAT POWDER see P001
	FEMMA see P091
P055	Ferric cyanide
P056	Fluorine
P057	2-Fluoroacetamide
P058	Fluoroacetic acid, sodium salt
	FOLODOL-80 see P071
	FOLODOL M see P071
	FOSFERNO M 50 see P071
	FRATOL see P058
	Fulminate of mercury see P065
	FUNGITOX OR see P092
	FUSSOF see P057
	GALLOTOX see P092
	GEARPHOS see P071
	GERUTOX see P020
P059	Heptachlor
P060	1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-endo, endo-dimethanonaphthalene
	1,4,5,6,7,7-Hexachloro-cyclic-5-norbomene-2,3-dimethanol sulfite see P050
P061	Hexachloropropene
P062	Hexaethyl tetraphosphate
	HOSTAQUICK see P092
	HOSTAQUIK see P092
	Hydrazomethane see P068

TABLE 5 (continued)

DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF, CLASSIFIED AS HAZARDOUS WASTE, BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
P063	Hydrocyanic acid
	ILLOXOL see P037
	INDOCI see P025
	Indomethacin see P025
	INSECTOPHENE see P050
	Isodrin see P060
P064	Isocyanic acid, methyl ester
	KILOSEB see P020
	KOP-THIODAN see P050
	KWIK-KIL see P108
	KWIKSAN see P092
	KUMADER see P001
	KYPFARIN see P001
	LEYTOSAN see P092
	LIQUIPHENE see P092
	MALIK see P050
	MAREVAN see P001
	MAR-FRIN see P001
	MARTIN'D MAR-FIN see P001
	MAVERAN see P001
	MEGATOX see P005
P065	Mercury fulminate
	MERSOLITE see P092
	METACID 50 see P071
	METAFOS see P071
	METAPHOR see P071
	METHAPOS see P071
	METASOL 30 see P092
P066	Methomyl
P067	2-Methylazindine
	METHYL-E 605 see P071
P068	Methyl hydrazine
	Methyl isocyanate see P064
P069	2-Methyllactonitrile
P070	2-Methyl-2-(methylthio)propionaldehyde-o-(methylcarbonyl)oxime
	METHYL NIRON see P042
P071	Methyl parathion
	METRON see P071
	MOLE DEATH see P108
	MOUSE-NOTS see P108

TABLE 5 (continued)

DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF, CLASSIFIED AS HAZARDOUS WASTE, BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
	MOUSE-RID see P108
	MOUSE-TOX see P108
	MUSCIMOL see P007
P072	1-Naphthyl-2-thiourea
P073	Nickel carbonyl
P074	Nickel cyanide
P075	Nicitine and salts
P076	Nitric oxide
P077	p-Nitroaniline
P078	Nitrogen dioxide
P079	Nitrogen perioxide
P080	Nitrogen tetroxide
P081	Nitroglycerine (R)
P082	N-Nitrosodimethylamine
P083	N-Nitrosodiphenylamine
P084	N-Nitrosomethylvinylamine
	NYLMERATE see P092
	OCTALOX see P037
P085	Octamethylpyrophosphoramide
	OCTAN see P092
P086	Oleyl alcohol condensed with 2 moles ethylene oxide
	OMPA see P085
	OMPACIDE see P085
	OMPAX see P085
P087	Osmium tetroxide
P088	7-Oxabicyclo(2.2.1)heptane-2,3-dicarboxylic acid
	PANIVARFIN see P001
	PANORAM D-31 see P037
	PANTHERINE see P007
	PANWARFIN see P001
P089	Parathion
	PCP see P090
	PENNCAP-M see P071
	PENOXYL CARBON N see P048

TABLE 5 (continued)

DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF, CLASSIFIED AS HAZARDOUS WASTE, BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
P090	Pentachlorophenol
	Pentachlorophenate see P090
	PENTA-KILL see P090
	PENTASOL see P090
	PENWAR see P090
	PERMICIDE see P090
	PERMAGUARD see P090
	PERMATOX see P090
	PERMITE see P090
	PERTOX see P090
	PESTOX III see P085
	PHENMAD see P092
	PHENOTAN see P020
P091	Phenyl dichloroarsine
	Phenyl mercaptan see P014
P092	Phenylmercury acetate
P093	N-Phenylthiourea
	PHILIPS 1861 see P008
	PHIX see P092
P094	Phorate
P095	Phosgene
P096	Phosphine
P097	Phosphorothioci acid, 0,0-dimethyl ester; 0-ester with N,N-dimethyl benzene sulfonamide
	Phosophorothioic acid 0,0-dimethyl-0-(p,nitrophenyl)ester see P071
	PIED PIPER MOUSE SEED SEE P108
P098	Potassium cyanide
P099	Potassium silver cyanide
	PREMERGE see P020
P100	1,2-Propanediol
	Propargyl alcohol see P102
P101	Propionitrile
P102	2-Propyn-1-of
	PROTHROMADIN see P001
	QUICKSAM see P092
	QUINTOX see P037
	RAT AND MICE BAIT see P001

TABLE 5 (continued)

DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF, CLASSIFIED AS HAZARDOUS WASTE, BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
	RAT-A-WAY see P001
	RAT-B-GON see P001
	RAT-O-CIDE #2 see P001
	RAT-GUARD see P001
	RAT-KILL see P001
	RAT-MIX see P001
	RATS-NO-MORE see P001
	RAT-OLA see P001
	RATOREX see P001
	RATTUNAL see P001
	RAT-TROL see P001
	RO-DETH see P001
	RO-DEX see P108
	ROSEX see P001
	ROUGH & READY MOUSE MIX see P001
	SANASEED see P018
	SANTOBRITE see P090
	SANTOPHEN see P090
	SANTOPHEN 20 see P090
	SCHRADAN see P185
P103	Sefenourea
P104	Silver Cyanide
	SMITE see P105
	SPARIC see P020
	SPOR-KIL see P092
	SPRAY-TROL BRAND RODEN-TROL see P001
	SPURGE see P020
P105	Sodium azide
	Sodium coumadin see P001
P106	Sodium cyanide
	Sodium fluoroacetate see P056
	SODIUM WARFARIN see P001
	SOLFARIN SEE P001
	SOLFOBLACK BB see P048
	SOLFOBLACK SB see P048
P107	
P108	Strychrine and salts
	SUBTEX and P020
	SYSTAN see P085
	TAG FUNGICIDE see P092
	TEKWAISA see P071
	TEMIC see P070
	TEMIK see P070
	TERM-1-TROL see P090

TABLE 5 (continued)

DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF, CLASSIFIED AS HAZARDOUS WASTE, BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste NO.	Substance
P109	Tetraethyldithiopyrophosphate
P110	Tetraethyl lead
P111	Tetraethylpyrophosphate
P112	Tetranitromethane
	Tetraphosphoric acid, hexaethyl ester see P062
	TETROSULFUR BLACK PB see P048
	TETROSULPHUR PBR see P048
P113	Thalic oxide
	Thallium peroxide see P113
P114	Thallim selenite
P115	Thalium (1) sulfate
	THIFOR see P092
	THIMUL see P092
	THIDDAN see P050
	THIOFOR see P050
	THIOMUL see P050
	THIONEX see P050
	THIOPHENT see P071
P116	Thiosemicarbazide
	Thiosulfan tionel see P050
P117	Thiuram
	THOMPSON'S WOOD FIX see P090
	TIOVEL see P050
P118	Trichloromethanethiol
	TWIN LIGHT RAT AWAY see P001
	USAF RH-8 see P069
	USAF EK-4890 see P002
P119	Vanadic acid, ammonium salt
P120	Vanadium pentoxide
	VOFATOX see P071
	WANADU see P120
	WARCOUMIN see P001
	WARFARIN SODIUM see P001
	WARFICIDE see P001
	WOFOTOX see P072
	YANOCK see P057
	YASOKNOCK see P058
	ZIARNIK see P092

TABLE 5 (continued)

DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF, CLASSIFIED AS HAZARDOUS WASTE, BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
P121	Zinc cyanide
P122	Zinc phosphide (R,T)
	ZOOCOUMARIN see P001

Source: "Identification and Listing of Hazardous Waste", Environmental Protection Agency, Part III, Federal Register, May 19, 1980.

Page 10 of 10

TABLE 6

COMMERCIAL CHEMICAL PRODUCTS OR MANUFACTURING CHEMICAL INTERMEDIATES IDENTIFIED AS TOXIC WASTES BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance 1/
	AAF see U005
U001	Acetaldehyde
U002	Acetone (1)
U003	Acetonitrile (1,T)
U004	Acetophenone
U005	2-Acetylaminoliourene
U006	Acetyl chloride (C,T)
U007	Acrylamide
	Acetylene tetrachloride see U209
	Acetylene trichloride see U228
U008	Acrylic acid (1)
U009	Acrylonitrile
	AEROTHENE TT see U226
	3-Amino-5-(p-acetamidophenyl)-1H-1,2,4-triazole, hydrate see U011
U010	6-Amino-1,1a,2,8,8a,8b-hexahydro-8-(hydroxymethyl) 8-methoxy-5-methylcarbamate azirino(2,3,3,4) pyroio)1,2,a) indole-4,7-dione (ester)
U011	Amitrole
U012	Aniline (1)
U013	Asbestos
U014	Auramine
U015	Azaserine
U016	Benz(c)acridine
U017	Benzal chloride
U018	Benz(a)anthracene
U019	Benzene
U020	Benzenesulfonyl chloride (C,R)
U021	Benzidine
	1,2-Benzisothiazolin-3-one, 1,1-dioxide see U202
	Benzo(a)anthracene see U018

TABLE 6 (continued)

COMMERCIAL CHEMICAL PRODUCTS OR MANUFACTURING CHEMICAL INTERMEDIATES IDENTIFIED AS TOXIC WASTES BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
U022	Benzo(a)pyrene
U023	Benzotrichloride (C,R,T)
U024	Bis(2-chloroethoxy)methane
U025	Bis(2-chloroethyl) ether
U026	N,N-Bis(2-chloroethyl)-2-naphthylamine
U027	Bis(2-chloroisopropyl)ether
U028	Bis(2-ethylhexyl) phthalate
U029	Bromonethane
U030	4-Bromophenyl phenyl ether
U031	n-Butyl alcohol (1)
U032	Calcium chromate
	Carbolic tetrachloride see U211
	Carbon tetrachloride see U211
U033	Carbonyl fluoride
U034	Chloral
U035	Chlorambucil
U036	Chlordane
U037	Chlorobenzene
U038	Chlorobenzilate
U039	p-Chloro-m-cresol
U040	Chlorodibromomethane
U041	1-Chloro-2,3-epoxypropane
	CHLOROETHENE NU see U226
U042	Chloroethyl vinyl ether
U043	Chlorothene
U044	Chloroform (1,T)
U045	Chloromethane (1,T)
U046	Chloromethyl, methyl ether
U047	2-Chloronaphthalene
U048	2-Chlorophenol

Page 2 of 9

TABLE 6 (continued)

COMMERCIAL CHEMICAL PRODUCTS OR MANUFACTURING CHEMICAL INTERMEDIATES IDENTIFIED AS TOXIC WASTES BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
U049	4-Chloro-o-toluidine hydrochloride
U050	Chrysene
	C.1. 23060 see U073
U051	Cresote
U052	Cresols
U053	Crotonaldehyde
U054	Cresylic acid
U055	Cumene
	Cyanomethane see U003
U056	Cyclohexane (1)
U057	Cyclohexanone (1)
U058	Cyclophosphamide
U059	Daunomycin
U060	DDD
U061	DDT
U062	Diallate
U063	Dibenz(a,h)anthracene
	Dibenso (a,h)anthracene see U063
U064	Dibenso(a,h)pyrene
U065	Dibromochloromethane
U066	1,20Dibromo-3-chloropropane
U067	1,2-Dibromoethane
U068	Dibromomethane
U069	Di-n-butyl phthalate
U070	1,2-Dichlorobenzene
U071	1,3-Dichlorobenzene
U072	1,4-Dichlorobenzene
U073	3,3-Dichlorobenzidine
U074	1,4-Dichloro-2-butene
	3,3-Dichloro-4,4-diaminobiphenyl see U-73
U075	Dichlorodifluoromethane
U076	1,1-Dichloroethane

TABLE 6 (continued)

COMMERCIAL CHEMICAL PRODUCTS OR MANUFACTURING CHEMICAL INTERMEDIATES IDENTIFIED AS TOXIC WASTES BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
U078	1,1-Dichloroethylene
U079	1,2-trane-dichloroethylene
U080	Dichloromethane Dichloromethylbenzene see U017
U081	2,4-Dichlorophenol
U082	2,6-Dichlorophenol
U083	1,2-Dichloropropane
U084	1,3-Dichloropropene
U085	Diepoxybutane (1,T)
U086	1,2-Diethylhydrazine
U087	0,0-Diethyl-S-methyl ester of phosphorodithioic acid
U088	Diethyl phthalate
U089	Diethylstilbestro
U090	Dithydrosafrole
U091	3,3-Dimethoxybenzidine
U092	Dimethylamine (1)
U093	p-Dimethylaminoazobenzene
U094	7,12-Dimethylbenz(a)anthracene
U095	3,3-Dimethylbenzidine
U096	alpha,alpha-Dimethylbenzylhydroperoxide (R)
U097	Dimethylcarbamoyl chloride
U098	1,1-Dimethylhydrazine
U099	1,2-Dimethylhydrazine
U100	Dimethylnitrosoamine
U101	2,4-Dimethylphenol
U102	Dimethyl phthalate
U103	Dimethyl sulfate
U104	2,4-Dinitrophenol
U105	2,4-Dinitrotoluene
U106	2,6-Dinitrotoluene

TABLE 6 (continued)

COMMERCIAL CHEMICAL PRODUCTS OR MANUFACTURING CHEMICAL INTERMEDIATES IDENTIFIED AS TOXIC WASTES BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
U107	Di-n-octyl phtahalate
U108	1,4-Dioxane
U109	1,2-Diphenylhydrazine
U110	Dipropylamine (1)
U111	Di-n-propylnitrosamine
	EBDC see U114
	1,4-Epoxybutane see U213
U112	Ethyl acetate (2)
U113	Ethyl acrylate (1)
U114	Ethylenebisdithiocarbamate
U115	Ethylene oxide (1,T)
U116	Ethylene thiourea
U117	Ethyl ether (1,T)
U118	Ethylmethacrylate
U119	Ethyl methanesulfonate
	Ethylnitrile see U003
	Firemaster T23P see U235
U120	Fluoranthene
U121	Fluorotrichloromethane
U122	Formaldehyde
U123	Formic acid (C,T)
U124	Furan (1)
U125	Fufural (1)
U126	Glycidylaldehyde
U127	Hexachlorobenzene
U128	Hexachlorobutadiene
U129	Hexachlorocyclonexane
U130	Hexachlorobyclopentadiene
U131	Hexachloroethane
U132	Hexachlorophene
U133	Hydrazine (R,T)
U134	Hydrofluoric acid (C,T)

TABLE 6 (continued)

COMMERCIAL CHEMICAL PRODUCTS OR MANUFACTURING CHEMICAL INTERMEDIATES IDENTIFIED AS TOXIC WASTES BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
U135	Hydrogen sulfide
	Hydroxybenzene see U188
U136	Hydroxydimethyl arsine oxide
	4,4'-(Imidocarbonyl)bis(N,N-dimethyl)aniline see U014
U137	Indenol (1,2,3-cd)pyrene
U138	Iodomethane
U139	Iron Dextran
U140	Isobutyl Alcohol
U141	Isosafrole
U142	Kepone
U143	Lasiocarpine
U144	Lead acetate
U145	Lead phosphate
U146	Lead subacetate
U147	Maleic anhydride
U148	Maleic hydrazide
U149	Malononitrile
	MEK Peroxide see U160
U150	Melphalan
U151	Mercury
U152	Methacrylonitrile
U153	Methanethiol
U154	Methanol
U155	Methapyrilene
	Methyl alcohol see U154
U156	Methyl chlorocarbonate
	Methyl chloroform see U226
U157	3-Methylcholanthrene
	Methyl chloroformate see U156
U158	4,4'-methylene-bis-(2-chloraniline)
U159	Methyl ethyl ketone (MEK) (1,T)
U160	Methyl ethyl ketone peroxide (R)
	Methyl iodide see U138

Page 6 of 9

TABLE 6 (continued)

COMMERCIAL CHEMICAL PRODUCTS OR MANUFACTURING CHEMICAL INTERMEDIATES IDENTIFIED AS TOXIC WASTES BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
U161	Methyl isobutyl ketone
U162	Methyl methacrylate (R,T)
U163	N-Methyl-N-nitro-N-nitrosoguanidine
U164	Methylthiouracil
	Mitomycin C see U010
U165	Naphthalene
U166	1,4-Naphthoquinone
U167	1-Naphthylamine
U168	2-Naphthylamine
U169	Nitrobenzene (1,T)
	Nitrobenzol see U169
U170	4-Nitrophenol
U171	2-Nitropropane (1)
U172	N-Nitrosodi-n-butylamine
U173	N-Nitrosodiethanolamine
U174	N-Nitrosodiethylamine
U175	N-Nitrosodi-n-propylamine
U176	N-Nitroso-n-ethylurea
U177	N-Nitroso-n-methylurea
U178	N-Nitroso-n-methylurethane
U179	N-Nitrosopiperidine
U180	N-Nitrosopyrrolidine
U181	5-Nitro-o-toluidine
U182	Paraldehyde
	PCNB see U185
U183	Pentachlorobenzene
U184	Pentachloroethane
U185	Pentachloronitrobenzene
U186	1,3-Pentadiene (1)
	Perc see U210
	Perchlorethylene see U210
U187	Phenacetin
U188	Phenol

TABLE 6 (continued)

COMMERCIAL CHEMICAL PRODUCTS OF MANUFACTURING CHEMICAL INTERMEDIATES
IDENTIFIED AS TOXIC WASTES BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
U189	Phosphorous sulfide (R)
U190	Phthalic anhydride
U191	2-Picoline
U192	Pronamide
U193	1,3-Propane sultone
U194	n-Propylamine (1)
U196	Pyridine
U197	Quinones
U200	Reserpine
U201	Resorcinol
U202	Saccharin
U203	Safrole
U204	Selenious acid
U205	Selenium sulfide (R,T)
	Silvex see U233
U206	Streptozotocin
	2,4,5-T see U232
U207	1,2,4,5-Tetrachlorobenzene
U208	1,1,1,2-Tetrachloroethane
U209	1,1,2,2,-Tetrachloroethane
U210	Tetrachloroethene
	Tetrachloroethylene see U210
U211	Tetrachloromethane
U212	2,3,4,6-Tetrachlorophenol
U213	Tetrahydrofuran (1)
U214	Thalium (1) acetate
U215	Thalium (1) carbonate
U216	Thalium (1) chloride
U217	Thalium (1) nitrate
U218	Thioacetamide
U219	Thiourea
U220	Toluene

TABLE 6 (continued)

COMMERCIAL CHEMICAL PRODUCTS OF MANUFACTURING CHEMICAL INTERMEDIATES IDENTIFIED AS TOXIC WASTES BY THE ENVIRONMENTAL PROTECTION AGENCY

Hazardous Waste No.	Substance
U221	Toluenediamine
U222	o-Toluidine hydrochloride
U223	Toluene disocyanate
U224	Toxaphene
	2,4,5-TP see U233
U225	Tribomomethane
U226	1,1,1-Trichloroethane
U227	1,1,2-Trichloroethane
U228	Trichloroethene
	Trichloroethylene see U228
U229	Trichlorofluoromethane
U230	2,4,5-Trichlorophenol
U231	2,4,6-Trichlorophenol
U232	2,4,5-Trichlorophenoxyacetic acid
U233	2,4,5-Trichlorophenoaxypropionic acid alpha,
	alpha, alpha-Trichlorotoluene see U023
	TRI-CLENE see U228
U234	Trinitrobenzene (R,T)
U235	Tris(2,3-dibromopropyl)phosphate
U236	Trypan blue
U237	Uracil mustard
U238	Urethane
	Vinyl chloride see U043
	Vinylidene chloride see U078
U239	Xylene

1/ The Agency included those trade names of which it was aware; an omission of a trade name does not imply that it is not hazardous. The material is hazardous if it is listed under its generic name.

Source: "Identification and Listing of Hazardous Wastes", Environmental Protection Agency, Part III, Federal Register, May 19, 1980.

TABLE 7

MAXIMUM CONCENTRATION OF CONTAMINANTS FOR CHARACTERISTIC OF EP TOXICITY

EPA Hazardous Waste Number	Contaminant	Maximum Concentration (milligrams per liter)
D004	Arsenic	5.0
D005	Barium	100.0
D006	Cadmium	1.0
D007	Chromium	5.0
D008	Lead	5.0
D009	Mercury	0.2
D010	Selenium	1.0
D011	Silver	5.0
D012	Endrin (1,2,3,4,10,10-hexachloro-1,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo,endo-5,8-dimethano naphthalene	0.02
D013	Lindane (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer	0.4
D014	Methoxychlor (11,1,1-Trichloro 2,2-bis (p-methoxyphenyl)ethane)	10.0
D015	Toxaphene ($C_{10}H_{10}Cl_8$, Technical chlorinated camphene, 67-69 percent chlorine)	0.5
D016	2,4-D,(2,4-Dichlorophenoxyacetic acid)	10.0
D017	2,4-5 TP Silvex (2,4,5-Trichlorophenoxypropionic acid)	1.0

TABLE 8

EXEMPT QUANTITIES FOR HAZARD CLASSIFICATION

Hazard Category	Control Level of Toxic Component in Water, mg/L	Exempt Rate of Generation of Toxic Component, kg/mo
A	<0.00001	<1*
B	.00001-<0.001	<10
C	.001-<0.1	<100
D	.1-<10	<1000
E	10-<1000	<10,000
F	$\geq$1000	<100,000

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*Certain uniquely toxic wastes may be hazardous at lower rates of generation

TABLE 9

MAMMALIAN AND AQUATIC TOXICITY RANGES

Hazard Category	Mammalian Toxicity Rat LD50, mg/kg	Aquatic Toxicity Fish LC50, mg/L
A	<.5	<.1
B	.5-5	.1-1
C	5-50	1-10
D	50-500	10-100
E	500-5000	100-1000
F	>5000	>1000

TABLE 10

EXEMPT CONCENTRATIONS FOR HAZARD CLASSIFICATION

Hazard Category	Quantity of Toxic Component in Total Waste kg/100,000 kg	Exempt Concentration of Toxic Component in Total Waste, % by Weight
A	1	0.001
B	10	0.01
C	100	0.1
D	1000	1.0
E	10,000	10.0
F	100,000	100.0

TABLE 11

STATE REGULATION OF HAZARDOUS WASTE

Jurisdiction	Waste Criteria Inquiry 1	2	3	4	5	6
Alabama	x	x				
Alaska	x	x				
Arizona	x	x	x	x	x	
Arkansas	x	x				
California	x	x		x	x	x
Colorado	x					
Connecticut	x	x				
Delaware	x					
District of Columbia	x	x				
Florida	x	x				
Georgia	x	x			x	
Hawaii	x	x		x		
Idaho	x	x				
Illinois	x	x	x	x	x	x
Indiana						
Iowa	x	x		x	x	
Kansas	x			x	x	
Kentuck	x	x	x			
Louisi	x					
Maine						
Maryla	x	x		x		x
Massa ts	x	x		x		
Michi	x			x	x	
Minn	x					
Missi	x	x			x	
Miss	x					
Mon	x	x				
Neb	x	x				
Ne						

Page 1 of 2

TABLE 11 (Continued)

STATE REGULATION OF HAZARDOUS WASTE

Jurisdiction	Waste Criteria Inquiry 1	2	3	4	5	6
New Hampshire	x	x				
New Jersey	x	x		x		
New Mexico	x	x		x		
New York	x	x	x	x		
North Carolina	x	x				
North Dakota	x					
Ohio	x	x				
Oklahoma	x	x	x	x	x	
Oregon	x					
Pennsylvania	x	x	x			x
Puerto Rico						
Rhode Island	x	x	x			
South Carolina	x	x	x			
South Dakota						
Tennessee	x					
Texas	x	x				
Utah	x	x				
Vermont	x	x				
Virginia						
Washington	x	x	x			x
Wisconsin	x	x				
Wyoming	x					
TOTALS	45	34	8	13	9	5

Source: Michael J. Gilroy, "State Regulation of Hazardous Waste Disposal", Legal Division, The Coca Cola Company, Atlanta, Georgia, 1980

Page 2 of 2

TABLE 12

HAZARDOUS WASTE CLASSIFICATION CHARACTERISTICS, DEPARTMENT OF ENVIRONMENTAL CONTROL, STATE OF NEBRASKA

1. Toxicity
2. Flammability
3. Explosiveness
4. Corrosiveness
5. Reactivity
6. Oxidizing power
7. Irritation
8. Strong sensitizer
9. Bioconcentration
10. Heat generation
11. Poisonous characteristics

Source: Industrial and Hazardous Waste Generation in Nebraska, State of Nebraska Department of Environmental Control, 1976.

TABLE 13

CRITERIA FOR THE IDENTIFICATION OF CANDIDATES FOR NATIONAL DISPOSAL SITES

QUANTITY CRITERION

(1) Material is present in sizable quantities as a waste.

HAZARD CRITERIA

(1) Waste material is highly toxic.

(2) Waste material is toxic and not degraded, oxidized, reduced or combined to a nontoxic form by air, water, or soil organisms.

(3) Waste material is radioactive with long half-life and/or high level radiation.

(4) Waste material is spontaneously combustible or is an explosive sensitive to heat or mild shock.

TREATMENT CRITERIA

(1) No disposal method other than long term or permanent storage is considered adequate for the material.

(2) Adequate disposal techniques for the material are too specialized or complex for general application.

(3) Adequate disposal methods for the material are under development but not yet available, requiring short term storage.

TABLE 14

SUMMARY OF HAZARD EVALUATION CRITERIA

I	II	III	IV	V	VI	VII	VIII	XI
FIRE	HEALTH				WATER POLLUTION		REACTION	
	Skin and Eyes	Vapor Inhalation	Gas Inhalation	Repeated Inhalation	Human Toxicity	Aquatic Toxicity	Water Reaction	Self-Reaction
Insignif. Hazard Non-combust	Insignif. Hazard All not described below	Insignif. Hazard All not described below	Not Applicable	Insignif. Hazard OSHA ≥ 1000 ppm	Insignif. Hazard LD_{50} > 5000 mg/kg	Insignif. Hazard TL_m >1000mg/l	Insignif. Hazard	Insignif. Hazard No appreciable self-reaction
Slightly Hazardous FPcc > 140°F (60°C)	Slightly Hazardous Corrosive to eyes-	Slightly Hazardous Depressants, Asphyxiants	All those not described below	Slightly Hazardous OSHA 100-1000 ppm	Slightly Hazardous LD_{50} 500-5000mg/kg	Practically Nontoxic TL_m 100-1000 mg/l	Slightly Hazardous e.g. Cl_2	Slightly Hazardous May polymerize with low heat evolution
Hazardous FPcc 100°F-140°F (37.8°-60°C)	Moderately Hazardous Corrosive to skin	Moderately Hazardous LC_{50} 200-2000 ppm	Moderately Hazardous LC_{50} 200-2000ppm	Moderately Hazardous OSHA 10-100 ppm	Moderately Hazardous LD_{50} 50-500/mg/kg	Slightly Toxic TL_m 10-100 mg/l	Hazardous e.g. NH_3	Hazardous Contamination may cause polymerization, no inhibitor required
Highly Hazardous (37.8°C) FPcc < 100°F BP > 100°F (37.8°C)	Highly Hazardous ↓ LD_{50} 20-200mg/kg 24 hr. skin contact	Highly Hazardous ↓ LC_{50} 50-200ppm or 0.5-2 mg/l	Highly Hazardous ↓ LC_{50} 50-200 ppm	Highly Hazardous OSHA 1-10 ppm	Highly Hazardous ↓ LD_{50} 5-50 mg/kg	Moderately. Toxic TL_m 1-10 mg/l	Highly Hazardous e.g. Oleum	Highly Hazardous May polymerize, requires stabilizer
Extremely Hazardous (37.8°C) FPcc < 100°F BP < 100°F (37.8°C)	Extremely Hazardous $LD_{50} \leq$ 20mg 24 hr. skin contact	Extremely Hazardous $LC_{50} \leq$ 50ppm or ≤ 0.5 mg/l	Extremely Hazardous $LC_{50} \leq$ 50ppm	Extremely Hazardous OSHA < 1ppm	Extremely Hazardous LD_{50} < 5 mg/kg	Highly Toxic + TL_m < 1 mg/l	Extremely Hazardous e.g. SO_3	Extremely Hazardous Self-reaction may cause explosion or detonation

TABLE 15

PERSISTENCE (BIODEGRADABILITY) OF SOME ORGANIC COMPOUNDS

LEVEL 0: NONPERSISTENT COMPOUNDS

acetaldehyde
acetic acid
acetone
acetophenone
benzoic acid
di-isobutyl carbinol
docosane
eicosane
ethanol
ethylamine
hexadecane
methanol
methyl benzoate
3-methyl butanol
methyl ethyl ketone
2-methylpropanol
octadecane
pentadecane
pentanol
propanol
propylamine
tetradecane
n-tridecane
n-undecane

Page 1 of 6

TABLE 15 (Continued)

PERSISTENCE (BIODEGRADABILITY) OF SOME ORGANIC COMPOUNDS

LEVEL 1: SOMEWHAT PERSISTENT COMPOUNDS

acetylene dichloride
behenic acid, methyl ester
benzene
benzene sulfonic acid
butyl benzene
butyl bromide
e-caprolactam
carbon disulfide
o-cresol
decane
1,2-dichloroethane
1,2-dimethoxy benzene
1,3-dimethyl naphthalene
1,4-dimethyl phenol
dioctyl adipate
n-dodecane
ethyl benzene
2-ethyl-n-hexane
o-ethyltoluene
isodecane
isopropyl benzene
limonene
methyl ester of lignoceric acid
methane
2-methyl-5-ethyl-pyridine
methyl naphthalene
methyl palmitate
methyl phenyl carbinol
methyl stearate
naphthalene
nonane
octane
octyl chloride
pentane
phenyl benzoate
phthalic anhydride
propylbenzene
1-terpineol
toluene
vinyl benzene
xylene.

TABLE 15 (Continued)

PERSISTENCE (BIODEGRADABILITY) OF SOME ORGANIC COMPOUNDS

LEVEL 2: PERSISTENT COMPOUNDS

acenaphthylene
atrazine
(diethyl) atrazine
barbital
borneol
bromobenzene
camphor
chlorobenzene
1,2-bis-chloroethoxy ethane
b-chloroethyl methyl ether
chloromethyl ether
chloromethyl ethyl ether
3-chloropyridine
di-t-butyl-p-benzoquinone
dichloroethyl ether
dihydrocarvone
dimethyl sulfoxide
2,6-dinitrotoluene
cis-2-ethyl-4-methyl-1,3-dioxolane
trans-2-ethyl-4-methyl-1,3-dioxolane
guaiacol
2-hydroxyadiponitrile
isophorone
indene
isoborneol
isopropenyl-4-isopropyl benzene
2-methoxy biphenyl
methyl biphenyl
methyl chloride
methylindene
methylene chloride
nitroanisole
nitrobenzene
tetrachloroethylene
1,1,2-trichloroethylene
trimethyl-trioxo-hexahydro-triazine isomer

TABLE 15 (Continued)

PERSISTENCE (BIODEGRADABILITY) OF SOME ORGANIC COMPOUNDS

LEVEL 3: HIGHLY PERSISTENT COMPOUNDS

aldrin
benzopyrene
benzothiazole
benzothiophene
benzyl butyl phthalate
bromochlorobenzene
bromoform butanal
bromophenyl phenyl ether
chlordane
chlorohydroxy benzophenone
bis-chloroisopropyl ether
m-chloronitrobenzene
DDE
DDT
dibromobenzene
dibutyl phthalate
1,4-dichlorobenzene
dichlorodifluoroethane
dieldrin
diethyl phthalate
di(2-ethylhexyl)phthalate
dihexyl phthalate
di-isobutyl phthalate
dimethyl phthalate
4,6-dinitro-2-aminophenol
dipropyl phthalate
endrin
heptachlor
heptachlor epoxide
1,2,3,4,5,7,7-heptachloronorbornene
hexachlorobenzene
hexachloro-1, 3-butadiene
hexachlorocyclohexane
hexachloroethane
methyl benzothiazole
pentachlorobiphenyl
pentachlorophenol
1,1,3,3-tetrachloroacetone
tetrachlorobiphenyl
thiomethylbenzothiazole
trichlorobenzene
trichlorobiphenyl
trichlorofluoromethane
2,4,6-trichlorophenol
triphenyl phosphate
bromodichloromethane
bromoform
carbon tetrachloride
chloroform
chloromochloromethane
dibromodichloroethane
tetrachloroethane
1,1,2-trichloroethane

*From: Abrams, E.F. et al., Identification of Organic Compounds in Effluents from Industrial Sources, EPA-560/3-75-002, April, 1975

TABLE 15 (continued)

PERSISTENCE (BIODEGRADABILITY) OF SOME ORGANIC COMPOUNDS

JRB LEVEL	N.F.P.A. LEVEL
3	4 Very flammable gases, very volatile flammable liquids, and materials that in the form of dusts or mists readily form explosive mixtures when dispersed in air. Shut off flow of gas or liquid and keep cooling water streams on exposed tanks or containers. Use water spray carefully in the vicinity of dusts so as not to create dust clouds.
	3 Liquids which can be ignited under almost all normal temperature conditions. Water may be ineffective on these liquids because of their low flash points. Solids which form coarse dusts, solids in shredded or fibrous form that create flash fires, solids that burn rapidly, usually because they contain their own oxygen, and any material that ignites spontaneously at normal temperatures in air.
2	2 Liquids which must be moderately heated before ignition will occur and solids that readily give off flammable vapors. Water spray may be used to extinguish the fire because the material can be cooled to below its flash point.
1	1 Materials that must be preheated before ignition can occur. Water may cause frothing of liquids with this flammability rating number if it gets below the surface of the liquid and turns to stream. However, water spray gently applied to the surface will cause a frothing which will extinguish the fire. Most combustible solids have a flammability rating of 1.
0	0 Materials that will not burn.

Reactivity is a measure of the explosion threat of a site, and is also based on the classification of the N.F.P.A.

TABLE 15 (continued)

PERSISTENCE (BIODEGRADABILITY) OF SOME ORGANIC COMPOUNDS

JRB LEVEL	N.F.P.A. LEVEL
3	4 Materials which in themselves are readily capable of detonation or of explosive decomposition or explosive reaction at normal temperatures and pressures. Includes materials which are sensitive to mechanical or localized thermal shock. If a chemical with this hazard rating is in an advanced or massive fire, the area should be evacuated. 3 Materials which in themselves are capable of detonation or of explosive decomposition or of explosive reaction but which requires a strong initiating source or which must be heated under confinement before initiation. Includes materials which are sensitive to thermal or mechanical shock at elevated temperatures and pressures or which react explosively with water without requiring heat or confinement. Fire fighting should be done from an explosion-resistant location.
2	2 Materials which in themselves are normally unstable and readily undergo violent chemical change but do not detonate. Includes materials which can undergo chemical change with rapid release of energy at normal temperatures and pressures or which can undergo violent chemical change at elevated temperatures and pressures. Also includes those materials which may react violently with water or which may form potentially explosive mixtures with water. In advanced or massive fires, fire fighting should be done from a protected location.
1	1 Materials which in themselves are normally stable but which may become unstable at elevated temperatures and pressures or which may react with water with some release of energy but not violently. Caution must be used in approaching the fire and applying water.
0	0 Materials which are normally stable even under fire exposure conditions and which are not reactive with water. Normal fire fighting procedures may be used.

TABLE 16

GUIDANCE FOR ASSESSING THE PRESENCE OF INCOMPATIBLE WASTES

Incompatible Waste

Many wastes, when mixed with others at a hazardous waste facility, can potentially produce adverse human health and environmental effects through means such as the following: (1) heat generation, (2) violent reaction, (3) release of toxic fumes and gases as a result of mixing, (4) release of toxic substances in case of fire or explosion, (5) fire or explosion, and (6) generation of flammable or toxic gases.

Below is a summary list of potentially incompatible waste materials or components and the adverse consequences resulting from mixing of waste in one group with waste in another group.

The mixing of a Group A waste with a Group B waste may have the potential consequence as noted.

Group 1-A

- Acetylene sludge
- Alkaline caustic liquids
- Alkaline cleaner
- Alkaline corrosive liquids
- Alkaline corrosive battery fluid
- Caustic wastewater
- Lime sludge and other corrosive alkalies
- Lime wastewater
- Lime and water
- Spent caustic

Group 1-B

- Acid sludge
- Acid and water
- Battery acid
- Chemical cleaners
- Electrolyte acid
- Etching acid liquid or solvent
- Liquid cleaning compounds
- Pickling liquor and other corrosive acids
- Spent acid
- Spent mixed acid
- Spent sulfuric acid

Potential consequences: Heat generation, violent reaction.

Group 2-A

- Asbestos waste and other toxic wastes
- Beryllium wastes
- Unrinsed pesticide containers
- Waste pesticides

Group 2-B

- Cleaning solvents
- Data processing liquid
- Obsolete explosives
- Petroleum waste
- Refinery waste
- Retrograde explosives
- Solvents
- Waste oil and other flammable and explosive wastes

Potential consequences: Release of toxic substances in case of fire or explosion.

TABLE 16 (Continued)

GUIDANCE FOR ASSESSING THE PRESENCE OF INCOMPATIBLE WASTES

Group 3-A	Group 3-B
Aluminum	Any waste in Group 1-A or 1-B
Beryllium	
Calcium	
Lithium	
Magnestium	
Potassium	
Sodium	
Zinc powder and other reactive metals and metal	

Potential consequences: Fire or explosion; generation of flammable hydrogen gas.

Group 4-A	Group 4-B
Alcohols	Any concentrated waste in Group 1-A or 1-B
Water	Calcium
	Lithium
	Methal hydrides
	Potassium
	Sodium
	SO,CI, SOCI, PCI, CH,SICI, and other water-reactive wastes

Potential consequences: Fire, explosion, or heat generating; generation of flammable or toxic gases.

Group 5-A	Group 5-B
Alcohols	Concentrated Group 1-A or 1-B wastes
Aldehydes	Group 3-A wastes
Halogentrd hydrocarbons	
Nitrated hydrocarbons and other reactive organic compounds and solvents	
Unsaturated hydrocarbons	

Potential consequences: Fire, explosion or violent reaction

TABLE 16 (continued)

GUIDANCE FOR ASSESSING THE PRESENCE OF INCOMPATIBLE WASTES

Group 6-A	Group 6-B
Spent cyanide and sulfide solutions	Group 1-B wastes

Potential Consequences: Generation of toxic hydrogen cyanide or hydrogen sulfide gas.

Group 7-A	Group 7-B
Chlorates and other strong oxidizers	Acetic acid and other organic acids
Chlorine	Concentrated minieral acid
Chlorites	Group 2-B wastes
Chromic acid	Group 3-A wastes
Hypochlorites	Group 5-A wastes and other flammable and combustible wastes
Nitrates	
Nitric acid, fuming	
Perchlorates	
Permanganates	
Peroxides	

Potential Consequences: Fire, explosion, or violent reaction.

Source: "Law, Regulations and Guidelines for Handling of Hazardous Waste," California Department of Health, February 1975.

TABLE 17

RATING FACTORS AND SCALES FOR EACH OF THE FOUR GENERIC AREAS

RATING FACTORS	RATING SCALE LEVELS			
	0	1	2	3
RECEPTORS				
POPULATION WITHIN 1,000 FEET	0	1 TO 25	26 TO 100	GREATER THAN 100
DISTANCE TO NEAREST DRINKING-WATER WELL	GREATER THAN 3 MILES	1 TO 3 MILES	3,001 FEET TO 1 MILE	0 TO 3,000 FEET
DISTANCE TO NEAREST OFF-SITE BUILDING	GREATER THAN 2 MILES	1 TO 2 MILES	1,001 FEET TO 1 MILE	0 TO 1,000 FEET
LAND USE/ZONING	COMPLETELY REMOTE (ZONING NOT APPLICABLE)	AGRICULTURAL	COMMERCIAL OR INDUSTRIAL	RESIDENTIAL
CRITICAL ENVIRONMENTS	NOT A CRITICAL ENVIRONMENT	PRISTINE NATURAL AREAS	WETLANDS, FLOODPLAINS, AND PRESERVED AREAS	MAJOR HABITAT OF AN ENDANGERED OR THREATENED SPECIES
PATHWAYS				
EVIDENCE OF CONTAMINATION	NO CONTAMINATION	INDIRECT EVIDENCE	POSITIVE PROOF FROM DIRECT OBSERVATION	POSITIVE PROOF FROM LABORATORY ANALYSES
LEVEL OF CONTAMINATION	NO CONTAMINATION	LOW LEVELS, TRACE LEVELS, OR UNKNOWN LEVELS	MODERATE LEVELS OR LEVELS THAT CANNOT BE SENSED DURING A SITE VISIT BUT WHICH CAN BE CONFIRMED BY A LABORATORY ANALYSIS	HIGH LEVELS OR LEVELS THAT CAN BE SENSED EASILY BY INVESTIGATORS DURING A SITE VISIT
TYPE OF CONTAMINATION	NO CONTAMINATION	SOIL CONTAMINATION ONLY	BIOTA CONTAMINATION	AIR, WATER, OR FOODSTUFF CONTAMINATION
DISTANCE TO NEAREST SURFACE WATER	GREATER THAN 5 MILES	1 TO 5 MILES	1,001 FEET TO 1 MILE	0 TO 1,000 FEET
DEPTH TO GROUNDWATER	GREATER THAN 100 FEET	51 TO 100 FEET	21 TO 50 FEET	0 TO 20 FEET
NET PRECIPITATION	LESS THAN -10 INCHES	-10 TO +5 INCHES	+5 TO +20 INCHES	GREATER THAN +20 INCHES
SOIL PERMEABILITY	GREATER THAN 50% CLAY	30% TO 50% CLAY	15% TO 30% CLAY	0 TO 15% CLAY
BEDROCK PERMEABILITY	IMPERMEABLE	RELATIVELY IMPERMEABLE	RELATIVELY PERMEABLE	VERY PERMEABLE
DEPTH TO BEDROCK	GREATER THAN 60 FEET	31 TO 60 FEET	11 TO 30 FEET	0 TO 10 FEET

Page 1 of 2

TABLE 17 (Continued)

RATING FACTORS AND SCALES FOR EACH OF THE FOUR GENERIC AREAS

RATING FACTORS	RATING SCALE LEVELS			
	0	1	2	3
WASTE CHARACTERISTICS				
TOXICITY	SAX'S LEVEL 0 OR NFPA'S LEVEL 0	SAX'S LEVEL 1 OR NFPA'S LEVEL 1	SAX'S LEVEL 2 OR NFPA'S LEVEL 2	SAX'S LEVEL 3 OR NFPA'S LEVELS 3 OR 4
RADIOACTIVITY	AT OR BELOW BACKGROUND LEVELS	1 TO 3 TIMES BACKGROUND LEVELS	3 TO 5 TIMES BACKGROUND LEVELS	OVER 5 TIMES BACKGROUND LEVELS
PERSISTENCE	EASILY BIODEGRADABLE COMPOUNDS	STRAIGHT CHAIN HYDROCARBONS	SUBSTITUTED AND OTHER RING COMPOUNDS	METALS, POLYCYCLIC COMPOUNDS AND HALOGENATED HYDROCARBONS
IGNITABILITY	FLASH POINT GREATER THAN 200° OR NFPA'S LEVEL 0	FLASH POINT OF 140° F. to 200° F, OR NFPA'S LEVEL 1	FLASH POINT OF 80° F. TO 140° F. OR NFPA'S LEVEL 2	FLASH POINT LESS THAN 80° F. OR NFPA'S LEVELS 3 OR 4
REACTIVITY	NFPA'S LEVEL 0	NFPA'S LEVEL 1	NFPA'S LEVEL 2	NFPA'S LEVELS 3 OR 4
CORROSIVENESS	pH OF 6 TO 9	pH OF 5 TO 6 OR 9 TO 10	pH OF 3 TO 5 OR 10 TO 12	pH OF 1 TO 3 OR 12 TO 14
SOLUBILITY	INSOLUBLE	SLIGHTLY SOLUBLE	SOLUBLE	VERY SOLUBLE
VOLATILITY	VAPOR PRESSURE LESS THAN 0.1 mm Hg	VAPOR PRESSURE OF 0.1 TO 25 mm Hg	VAPOR PRESSURE OF 78 TO 25 mm Hg	VAPOR PRESSURE GREATER THAN 78 mm Hg
PHYSICAL STATE	SOLID	SLUDGE	LIQUID	GAS
WASTE MANAGEMENT PRACTICES				
SITE SECURITY	SECURE FENCE WITH LOCK	SECURITY GUARD BUT NO FENCE	REMOTE LOCATION OR BREACHABLE FENCE	NO BARRIERS
HAZARDOUS WASTE QUANTITY	0 TO 250 TONS	251 TO 1,000 TONS	1,001 TO 2000 TONS	GREATER THAN 2,000 TONS
TOTAL WASTE QUANTITY	0 TO 10 ACRE FEET	11 TO 100 ACRE FEET	101 TO 250 ACRE FEET	GREATER THAN 250 ACRE FEET
WASTE INCOMPATIBILITY	NO INCOMPATIBLE WASTES ARE PRESENT	PRESENT, BUT DOES NOT POSE A HAZARD	PRESENT AND MAY POSE A FUTURE HAZARD	PRESENT AND POSING AN IMMEDIATE HAZARD
USE OF LINERS	CLAY OR OTHER LINER RESISTENT TO ORGANIC COMPOUNDS	SYNTHETIC OR CONCRETE LINER	ASPHALT-BASE LINER	NO LINER USED
USE OF LEACHATE COLLECTION SYSTEMS	ADEQUATE COLLECTION AND TREATMENT	INADEQUATE COLLECTION OR TREATMENT	INADEQUATE COLLECTION AND TREATMENT	NO COLLECTION OR TREATMENT
USE OF GAS COLLECTION SYSTEMS	ADEQUATE COLLECTION AND TREATMENT	COLLECTION AND CONTROLLED FLARING	VENTING OR INADEQUATE TREATMENT	NO COLLECTION OR TREATMENT
USE AND CONDITION OF CONTAINERS	CONTAINERS ARE USED AND APPEAR TO BE IN GOOD CONDITION	CONTAINERS ARE USED BUT A FEW ARE LEAKING	CONTAINERS ARE USED BUT MANY ARE LEAKING	NO CONTAINERS ARE USED

TABLE 19

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
CMA	5	Class I - High Hazard	Ignitability Corrosivity Reactivity Toxicity (Section of 3001 EPA)	Class I - Extract fails mutagenic and persistence tests; or is an organic material of the high acute toxicity; or is an organic material of moderate acute and fails persistence test; or contaminant at concentratio greater than 1000 times the National Interim Primary Drinking Water Standard (NIPDWS)	Yes	Class I Facilities - designed and operated for most hazardous waste in compliance with the full scope of Section 3001 regulations.	
		Class II - Moderate Hazard		Class II - Extract fails mutagenic test but does not fail resistence test; or is an organic materia of moderate acute toxicity and either fails accumulation potential test, but does not fail persistence test or does not fail accumulation test, but fails persistence test; or is an organic material of low acute toxicity that fails both accumulation potential and persistence test; or contains any contaminant at concentrations from 300 to 100 times wate standard, or		Class II Facilities - for wastes which present lesser degree of acute or chronic hazard	Standards for Class II as compared to Class I facilities based on the knowledge and experience of industrial companies.

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
				fails ignitability characteristics.			
		Class III - Low Hazard		Class III - Extract does not fail the accumulation potential test and does not fail a persistance test; or is an organic material of low acute toxicity and fails the accumulation test and passes a persistence test or passes the acumulation test; or contains any contaminant at concentrations from 100 to 300 times water standard; or fails the corrosive characteristic.		Class III facilities - for wastes with low potential hazard	Standards for Class III facilities based on good engineering practice
		Class IV - Special Wastes		Class IV - See EPA regulations on wastes generated in large volume with low hazard			
		Class V - Radioactive and Infectious		Class V - radioactive and infectious wastes			

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
Proposed Scheme #2	6		Exposure defined as a function of entry (i.e., form & quantity) and availability (movement stability, bioconcentration) & effect defined in terms of: 1) toxicity; 2) carcinogenicity; 3) mutagenicity; 4) teratogenicity	Continuum based on coupling of significant quantitative and concentrations of hazardous wastes and of effect & exposure	No		
Proposed Scheme #3	N/A	N/A	Relationship between degree of hazard of waste and the characteristic & location of the disposal	Continuum based on: 1) Hazard factors (ingestion, inhalation hazards & toxicity); 2) Hazard modification factors (bioaccumulation, biodegradation, potential for transfer, i.e., absorption in soil, water, solibity and volatiliy); 3) Applicability of incineration; 4) Handling properties (ignitability, corrosivity & reactivity).	Yes	1. Incineration at T=1200 C^{o}, R.T=2 seconds 2. Incineration meetin Clean Air standards 3. Landfill with best available leacheate control	Utilizes decision three (see Figure 5 in report)

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
						4. Landfill with minimal groundwater pollution potential 5. Landfill per standards for municipal garbage and refuse 6. Landfarming	
Proposed Scheme 14	3	Class I - Wastes which are life threatening	1)Toxicity 2)Reactivity 3)Certain listed wastes	In concentration greater than 100 ppm with oral mammalian LD_{50} of (5 mg/kg/ or agnatic LC_{50} of (1.0 mg/l)	No		
		Class II - wastes which pose a hazard during some phase of management	1)Ignitable wastes 2)Corrosive waste 3)Reactive waste 4)Toxicity	Flash point less than 37. C or is liable to ignite through friction etc. or is gas as defined in 49 CFR 173.300(b) or 49 CFR 173.51 PH less or equal to 2 or greater than or equal to 13, or corrodes steel at rate greater than 0.250 in this per year Extract yields concentration of substance which exceeds 100 times EPA National Interim Primary Drinking Water Standard			

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
		Class III - wastes which are hazardous only if not handled in proper manner	1) Ignitable waste 2) Corrosive waste 3) Reactive waste 4) Toxicity	Flash point less than 93° C. PH less or equal to 3 or greater or equal to 12. Extract yields concentration of substances which does not exceed 100 times Drinking Water Standards (NIPDWS)	No		
Proposed Scheme #5	2	Primary Hazardous Waste	1) Toxicity 2) Reactive wastes	LD50 value equal or less than 100 mg/kg or LC value equal or less than 20 ppm. Waste characterized by significant persistence, bioaccumulation carcinogenicity mutagenicity or teratogenicity; §250.13(d) at 100 times the NIPDWS, §250.13(c)(1)(i), (1)(iii) and (1)(iv).	No		
			3) Infectious wastes	Appendix VII 043 FR 58964			
		Special wastes	1) Toxicity	LD50 value between 100 mg/kg and 2500 mg/kg or LC/50 value between 20 ppm and 500 ppm; §250.13 (d) between 10 and 100 times NIPDWS.			

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
			1) Ignitable wastes	§250.13(a)(1)(i) and (1)(ii) or flash print equal to or less than 100°F.			
			2) Corrosive wastes	§250.13(b)(1)(i)			
			3) Reactive wastes	§250.13(c)(1)(ii)			
			4) Infectious wastes	Class B as classified by Joint Commission on Accrediting Hospitals or Class 2 as defined by CDC.			
Proposed Scheme #6	3	Extremely Hazardous		Extractive procedures	Yes	Tier I - Secure Landfill	
		Hazardous		Extractive procedures		Tier II - Industrial Landfill	
		Marginally hazardous		Extractive procedures		Tier III - Municipal Landfill	
Proposed Scheme #7	3	Class I	Wastes with serious continuing & persistent hazard	N/A	No		
		Class II	Wastes with moderate hazard	N/A			

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
		Class III	Wastes with no hazard when handled in prescribed manner	N/A			
Proposed Scheme #8	3	Class A - Primary Hazardous Waste Characteristics and Listing	Hazardous wastes which are ignitable or reactive	N/A	No		
		Class B - Secondary Hazardous Waste Characteristics and Listing	Corrosive wastes which are not itnitable or reactive	N/A			
		Class C - Tertiary Hazardous Wastes and Listing	Wastes which are hazardous	Chemical testing of the EP leacheate.			
Proposed Scheme #9	3	Class I	Wastes with constant Hazard	N/A	Yes	Should not be deposited in landfill	N/A
		Class II	Wastes with less constant hazard	N/A		Can be deposited in landfill	N/A

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	(f) Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
		Class III	Wastes with no hazard when handled in appropriate manner	N/A		Can be deposited in landfill	N/A
Proposed Scheme #10	3	High Hazard Waste/Group I	Wastes which present severe, imminent danger	N/A	No		
		Hazard Waste/ Group II	Wastes which pose danger if disposed indiscriminately	N/A			
		Marginally Hazardous/Group III	Wastes with low hazard	N/A			
Proposed Scheme #11	N/A	N/A	N.A	N/A	Yes	N.A	Facility standards to be related on the basis of containment

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
Proposed Scheme #12	5	Extremely Hazardous wastes	Waste with grave risk	N/A	No		
		Hazardous waste	Wastes with substantial risk	N/A			
		Dangerous waste	Wastes with possible toxic potential & are body rather than life threatening	N/A			
		Special Wastes	Wastes in the same degree of hazard which when removed allows wastes to be deposited in non-hazardous waste disposal, etc.	N/A			
		Other wastes	Wastes with small amount of some hazardous substance & can be disposed in sanitary landfill				

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
State of California	2	Extremely hazardous waste	1) Toxicity	Single oral LD50 ≤ 50 mg/kg; dermal LD50 ≤ 200 mg/kg; inhalation LC50 ≤ 200 ppm.	No		
			2) Carcinoge	Listed in Cal-OSHA section 5209 Title I.			
			3) Flammable	Flash point 37.8^{o}C; mixture of 13% or less forms flammable mixture			
			4) Reactive	CFR, Title 49, Sections 173.51; 173.53; 173.88 & 173.100 and is a water reactive material			
			5) Corrosive	pH ≤ 2 or ≥ 12			
			6) Irritant 7) Strong sensitize				
		Hazardous waste	1) Toxicity	Single oral LD50 ≤ 2000 mg/kg; dermal LD$_{50}$ ≤ 1200 mg/kg; inhalation LC$_{50}$ ≤ 4000 ppm.			
			2) Carcinoge	Listed in CAl-OSHA Title			
			3) Flammable	Flash point 37.8oC; mixture of 13% or less forms flammable mixture			
			4) Reactive	CFR, Title 49 Section 173.51; 173.53; 173.88 & 173.100 & in water reactive material			

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
			5) Corrosive	pH $\leq$ 2 or $\geq$ 12			
			6) Irritant				
			7) Strong sensitizer				
tate of exas	3	Class I	1) Hazard Index	$\leq$ 50 (see Text)	No		
			2) LD_{50}	$\leq$ 500 mg/kg			
			3) pH	$<$ 2.5 and $>$12			
			4) Corrosion rate of steel	$>$ 0.25 in/year (SAE 1020) at a test temperature 130°F.			
			5) Flash point	$\leq$ 140°F.			
		Class II	1) Hazard Index	$>$ 50 (See Text)			
			2) LD_{50}	$>$ 500 mg/kg			
			3) pH	2.5 to 12			
			4) Corrosion rate of steel	$<$ 0.25 in/year			
			5) Flash Point	$>$ 140°F.			
		Class III	1) Hazard Index	$>$50 (see Text)			
			2) LD_{50}	$>$ 500 mg/kg			
			3) pH	$<$ 2.5 to 12			
			4) Corrosion rate of steel	$>$ 0.25 in/year			

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
			Flash Point	140°F.			
State of Washington	2	Dangerous waste	1) LD_{50} (See Text	< 5g/kg	No		
			2) LC_{50} (See Text	< 1000 ppm			
			3) Etiologic agents				
		Extremely Hazardous Waste	1) LD_{50} (See Text	50 mg/kg			
			2) LC_{50} (See Text	> 10 ppm			
			3) Quantity	Waste exceeds 50 kg (100 lbs) providing $LD_{50} < 500$ mg/kg and $LC_{50} < 100$ ppm (See Text)			
			4) Persistence	Waste exceeds 50 kg and concentration of soluble heavey metals, halogenated HC on polycyclic, aromatic HC exceeds 1%			
			5) Corrosive	pH > 11 and < 3 when mixed equal weight of water			
			6) Explosive	WAC - Chapter 296-52			
			7) Flammable	Flash point below 100°F.			

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for
State of Rhode	17	Type 1A - Highly	1) LD_{50} or elutriate or	stance equal or greater than 10 times PDWs.			
			octanol/ water partition coefficient or	P greater than 3.0			
			5) Carcinogen	Contains any chemical designated as a carcinogen			
		Type 1B - Moderately Toxic Waste	1) LD_{50} or	<50 but >500 mg/kg			
			2) LC_{50} or	<71 ppm but >0.4 pp			
		Type 1C - Slightly toxic waste	1) LD_{50} or	<500 but $>5{,}000$mg/k			
			2) LC_{50} or	<1 ppm but >10ppm			
		Type 2A - Highly Reactive Waste	1) Itself readily capable of initiating a detonation				
		Type 2B - Moderately Reactive waste	2) Requires strong initiating source for detonation				

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
		Type 2C - Slightly Reactive Waste	1) Normally unstable, but does not detonate.				
		Type 3A - Highly Flammable Waste	1) Flash Point	Flash point beyween 73°F and boiling point less than 100°F.			
		Type 3B - Moderately Flammable Waste	1) Flash point	As above (See text)			
		Type 3C - Slightly Flammable waste	1) Flash point	Flash point above 100°F but below 200°F.			
		Type 4 - Corrosive waste	1) pH (See Text)	<3 and >12			
		Type 5 - Infectious Waste	1) Presence of micro-organisms	CDC classes 2 through 5			
		Type 6 - Radioactive waste	(See text)				
		Type 7 - Highly Irritating waste	1) Draize score	Score 6.6 to 8.0			
		Type 7B - Moderately Irritating Waste	1) Draize score	Score 3.1 to 6.5			
		Type 7C - Slightly Irritating Waste	1) Draize score	Score 1.6 to 3.0			

TABLE 19 (Continued)

SUMMARY DEGREE OF HAZARD CATEGORIZATION SCHEMES

Source	Number of Hazard Categories	Type of Hazard Categories	Basis for Hazard Categories	Standards for Hazard Categories	Facility Management Standards	Type of Facility Standards	Standards of Management for Facilities
		Type 8 - Strong Sensitizers	Produces Allergic sensitization				
		Type 9 - Hazardous N.O.S.	(See Text)				

HAZARDOUS WASTE CATEGORIES:
A REVIEW OF LITERATURE AND PAST RESEARCH EFFORT

APPENDICIES

Prepared for

Office of Technology Assessment
U.S. Congress

Prepared by

Sterling Hobe Corporation
1747 Pennsylvania Ave., N.W.
Washington, D.C. 20006

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APPENDIX A

INDIVIDUALS INTERVIEWED DURING THE COURSE OF THIS STUDY

Arnold L. Aspelin, PhD, Chief
Economic Analysis Branch
Benefits and Field Studies Division
Office of Pesticide Programs, E.P.A.
401 M Street, S.W.
Washington, D.C. 20460

Dr. Stanley M. Barkin
National Materials Advisory Board
2101 Constitution Ave.,
Washington, D.C.

Barbara A. Bassuener
Mgr. Water Quality Programs
Forest Industry Resource & Environment
American Paper Institute
National Forest Products Association
1619 Mass. Ave., N.W.
Washington, D.C. 20036

Gordon L. Brady, Ph.D.
Economic Analysis Division
National Commission on Air Quality
499 S. Capitol St., S.W.
Washington, D.C. 20003

Edward Burger, Jr., M.D.
President
Edward J. Burger Associates
1740 N Street, N.W.
Washington, D.C. 20036

Donald F. Barnett
Assistant Vice President
American Iron and Steel Institute
100 16th Street, N.W.
Washington, D.C. 20036

Louis Blair
Consultant to U.S. Radiation Policy Council
OST, Executive Office

John J. Cohrssen
Attorney at Law
1919 Pennsylvania Ave., N.W.
Washington, D.C. 20006

J. Clarence Davies, III
Executive Vice President
The Conservation Foundation
1717 Massachusetts Ave., N.W.
Washington, D.C. 20036

P.J. Danahy (Capt.)
U.S. Coast Guard
Cargo & Hazardous Material Division
Room 8308
400 Seventh St., S.W.
Washington, D.C. 20590

Charles N. Ehler
Director
Ocean Resources Coordination & Assessment
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Office of Coastal Management
2001 Wisconsin Ave., N.W.
Washington, D.C. 20036

Allan R. Ferguson, President
Public Interest Economics Center
2525 New Hampshire Ave., N.W.
Washington, D.C. 20036

Gary J. Foley
Acting Director
Energy and Air Division
OEPER/ORD (RD-682)
Environmental Protection Agency

Indur M. Goklany, Ph.D.
Chief
Technical Assessment Div.
National Commission on Air Quality
499 S. Capitol St., S.W.
Washington, D.C. 20003

Fred Hoerger, Ph.D., Dir.
Regulatory and Legislative Issues
Health & Environmental Sciences
Dow Chemical Co.
2030 Dow Center
Midland, Michigan 48640

Robert L. Harness
Manager, Regulatory Affairs
Monsanto
1101 17th St., N.W.
Washington, D.C. 20036

Juliane B. Harvey
Manager
Special Environmental Issues
Chemical Manufacturers Association
1825 Connecticut Ave., N.W.
Washington, D.C. 20009

Alan Hais
Chief, Municipal Technology Branch
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

James Herlihy
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Christopher Hill, Ph.D.
Senior Research Associate
Center for Policy Alternatives
MIT Room W59-204
Cambridge, Massachusetts 02139

Dr. Ferenc J. Juhasz
Environmental Directorate
OECD
2, rue Andre Pascal
75775 Paris Cedex 16

J. William Jordon
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dr. Charles A. Johnson
Technical Director
National Solid Wastes Management Association
1120 Connecticut Ave., N.W.
Suite 930
Washington, D.C. 20036

Ellie King
Information Officer
N.Y. Liaison Office
United Nations Environment Programme
Room A-3608
United Nations, New York 10017

Emmanuel Landau, Ph.D.
American Public Health Association
1015 Eighteenth St., N.W.
Washington, D.C. 20036

John P. Lehman
Director
Hazardous & Industrial Waste Division
U.S. Environmental Protection Agency
Office of Solid Waste
Washington, D.C. 20460

Joseph W. Mullan
Vice President - Government Relations
National Coal Association
1130 Seventeenth St., N.W.
Washington, D.C. 20036

Stanley V. Margolin
Arthur D. Little, Inc.
Acron Park
Cambridge, Mass. 02140

Richard E. Morrison
Div. of Policy Research & Analysis
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550

Lamar Miller
Response Energy

Joe J. Mayhew
Manager
Solid Waste Programs
Chemical Manufacturers Association
1825 Connecticut Ave., N.W.
Washington, D.C. 20009

O'Jay Niles
Director, Government Relations/
Regulatory
American Textile Manufacturers Institute, Inc.
1101 Connecticut Ave., N.W.
Washington, D.C. 20036

H. Christopher Nolde
Manufacturing Chemists Association
1825 Conneticut Ave., N.W.
Washington, D.C. 20009

Michel Potier, Ph.D.
Head of the Environment and Industry
Division
Environment Directorate
O.E.C.D.
2 Rue Andre-Pascal
75775 Paris Cedex 16

Lee Rawls
Senator Domenici Office
U.S. Congress
Washington, D.C. 20040

Anthony Z. Roisman
Chief Hazardous Waste Section
Land and Natural Resources Division
Department of Justice
Washington, D.C. 20530

William B. Sullivan
Deputy Director
Office of Regulatory Economics and Policy
U.S. Department of Commerce
Washington, D.C. 20230

Carl Shafer
Manager, Educational Affairs
Public Affairs Department
Dow Chemical Company
2030 Dow Center
Midland, Michigan 48640

David G. Sarvadi
Manager, Toxic Substances Control
Manufacturing Chemists Association
1825 Connecticut Ave., N.W.
Washington, D.C. 20009

Michael J. Toohey
Minority Professional Staff
Committee on Public Works and Transportation
U.S. House of Representatives
Washington, D.C. 20515

Christopher Wright
Carnegie Institution of Washington
1530 P Street, N.W.
Washington, D.C. 20005

Earle F. Young, Jr.
Assistant Vice President
Environmental Affairs
American Iron and Steel Institute
100 16th Street, N.W.
Washington, D.C. 20036

APPENDIX B

HAZARDOUS WASTE CATEGORIZATION BY INTERNATIONAL ORGANIZATIONS

Introduction

There has been considerable activity with regard to the planning, management and disposal issues of hazardous wastes by various international organizations. Unfortunately, as can be clearly seen from the material presented in this appendix, most of this activity remains in early stages with very limited results. In the case of hazardous waste categorization by degree of hazard,no completed categorization schemes exist although again there has been considerable discussion on this issue by the various international organizations.

The following sections of this chapter presents information pertaining to hazardous waste management effort undertaken by the international organizations.

Activities Related to United Nations Environmental Program

INFOTERRA: UNEP's World-Wide Information Network

INFOTERRA, formerly the International Referral System for Sources of Environmental Information (IRS), was established by the United Nations Environment Programme as a global network for the exchange of environmental information. Conceived as an integral component of EARTHWATCH, UNEP's environmental assessment programme, INFOTERRA was primarily designed to identify reliable sources of environmental information and to provide ready access to this information. While UNEP as a whole is dedicated to fostering global environmental awareness, INFOTERRA works in particular to catalyse and promote the flow of technical and other information on environmental concerns so that it can be readily available to environmental planners and decision-makers.

Design and Development

INFOTERRA grew out of Recommendation 101 of the United Nations Conference on the Human Environment in Stockholm in 1972. Following discussions of the Governing Council of UNEP, a task force of international experts developed system design criteria, which were reviewed at an intergovernmental meeting held in Nairobi in January, 1975.

Final design for the system was approved by the representatives of 60 countries and put into full operation in January, 1977, when INFOTERRA published the first edition of its International Directory of Sources of Environmental Information.

Financed by the Fund of UNEP and at the national level by each partner country, INFOTERRA is one of three program activity centres established so far as part of EARTHWATCH, an overall program involving monitoring, research, information exchange, review and evaluation. The others are GEMS, the Global Environmental Monitoring System, designed to co-ordinate measurement and analysis of environmental parameters and their trends, and IRPTC, the International Register of Potentially Toxic Chemicals, designed to provide information on natural and man-made chemicals occurring in the environment.

The INFOTERRA network is designed to carry out several specific functions. These include:

- the stimulation of international co-operation;
- the establishment of national machinery for environmental information;
- the promotion and co-ordination, among different components of individual national systems and among national systems as a whole, to encourage the flow of reliable information both within and between nations;
- the collecting, coding and classifying of sources of environmental information and maintaining these sources in national directories;
- the compilation of the INFOTERRA International Directory, available for use by governments world-wide;
- the processing of information requests from users.

Government-designated national referral centres known as national focal points (NFP's) provide a systematic mechanism by which users can be made aware of and communicate with those who have, and are willing to share, environmental information. At present a total of 101 NFP's serve as switchboards to connect users with appropriate sources of such information. Assisting then in this task is the International Directory of Sources, published quarterly in English, French, Spanish and Russian, the latest edition of which contains over 7000 sources from more than 65 different countries, classified by approximately 1000 different environmental topics.

Efforts are now underway to establish regional focal points (RFP's) by intergovernmental agreement. The first RFP has already been established for the Council of Mutual Economic Assistance (CMEA) region and Yugoslavia, and others are being considered by Latin America, Western Europe and elsewhere. The RFP's have various functions including registration of sources of regional scope, coordination, technical assistance and training, communication and liaison, and system evaluation. On a regional level the RFP's will reflect existing regional environmental structures and facilitate ongoing efforts to improve information exhcange.

Sectoral focal points (SFP's), designated by UNEP, are concerned solely with the international aspects of specific environmental topics. The Marine Environmental Data Information Referral System (MEDI) of the Intergovernmental Oceanographic Commission at UNESCO in Paris and the UNEP Industry and Environment Office have been established as INFOTERRA SFP's. Other SFP's include the Center for Human Settlements (HABITAT), IRPTC and other international organizations with environmental expertise.

The coordinating office of the network is the INFOTERRA Program Activity Center (PAC), based at UNEP Headquarters in Nairobi, which acts as a focal point for the UN family, international agencies and non-governmental organizations and countries not yet partners in the system. It maintains a direct connection with the UN computer in Geneva, enabling it to provide rapid response to queries from these bodies and data processing for NFP's currently without access to computer facilities.

INFOTERRA, as an international mechanism providing overall accessibility to information covering a wide range of topics, is based on a coding system sufficiently general to encompass a broad spectrum of information. The system was carefully designed so as not to limit its use to information specialists or even environmental scientists; its goal was to provide global access to all potential sources of environmental information. It could, however, prove extremely useful to scientist wishing to explore areas outside his own field or in a realted discipline and could prove of invaluable assistance as a means of interdisciplinary exchange. The system deals mainly with 25 broad categories of subjects namely: Atmosphere and climate; Biological agents and processes; Chemicals; Education, training and information; Energy-resources, supply and use; Food and Agriculture; Fresh water; Human health and well-being; Land use and misuse; Legislation and policy-making; Management and planning; Monitoring and assessment; Nature conservation; Noise and vibration; Oceans, seas and estuaries; Pollution; Population, human settlements and habitat; Radiation; Recreation and leisure; Renewable and non-renewable resources; Socio-economic effects; Technology and industry; Toxic substances; Wastes and Wildlife.

Codex Alimentarius Commission [1]

The Commission was established in 1962 to implement the Joint Food and Agriculture Organization/World Health Organization

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[1] One hundred and fourteen countries were members of the Commission at the time of its 11th Session, in April, 1976. For a comprehensive description of the program, see The Joint FAO/WHO Food Standards Program, CODEX Alimentarius Commission: Procedural Manual (4th ed. 1975) [hereinafter cited as CODEX Alimentarius Commission]; Shubber, The Codex Alimentarius Commission under International Law, 21 Int'l & Comp. L.Q. 631 (1972); The Joint FAO/WHO Food Standards Program and Related Activities of WHO: Codex Alimentarius, 190 Official Records of the World Health Organization 186 (1971).

TABLE 1B

ENVIRONMENTAL CARCINOGENIC AGENTS SELECTED BY WORLD HEALTH ORGANIZATION

1. Polynuclear compounds
2. Aromatic amines
3. Chlorinated hydrocarbons
4. N-nitroso compounds
5. Inorganic substances (selected)
6. Biological alkylating agents

Source: World Health Organization, Health Hazards of the Human Environment, Geneva, Switzerland, 1972.

TABLE 2B

ENVIRONMENTAL CHEMICAL TERATOGENIC AGENTS SELECTED BY WORLD HEALTH ORGANIZATION

Known	Strongly Suspected
Methylmercury	Cortisone
Aminopterin	Vitamin A deficiency
Thalidomide	Diethylstilboestrol
Iodine deficiency (cretinism)	
Steroid hormones with androgenic activity	
Carbon monoxide (hypoxia)	

Souece: World Health Organization, Health Hazards of the Human Environment, Geneva, Switzerland, 1972.

TABLE 3B

SELECTED ENVIRONMENTAL POLLUTANTS RATED AS SIGNIFICANTLY HAZARDOUS BY WORLD HEALTH ORGANIZATION

1. Arsenic
2. Cadmium
3. Lead
4. Mercury
5. Antimony
6. Barium
7. Beryllium
8. Cobalt
9. Manganese
10. Nickel
11. Selenium
12. Tin
13. Vanadium
14. Asbestos
15. Fluorides
16. Nitrates
17. Nitrites
18. Nitroso compounds
19. DDT and related compounds
20. Polychlorinated Biphenyls

Source: World Health Organization, Health Hazards of the Human Environment, Geneva, Switzerland, 1972.

WHO/FAO Pesticides Program

As early as 1953, WHO published a monograph on the toxic hazards of certain pesticides to man.[1] Since that time, it has undertaken a variety of programs relating to the control and regulation of pesticides,[2] and has cooperated with FAO in the preparation of the Codex Alimentarius Commission's recommended international maximum limits[3] for pesticide residues. A considerable amount of information relating to toxicity has been generated in the course of tests and studies of the effects of pesticides.

North Atlantic Treaty Organization Committee on the Challenges of Modern Society

The Committee was established by the North Atlantic Treaty Organization (NATO) in 1969 "to explore ways in which the experience and resources of the Western nations could most effectively be marshalled toward improving the quality of life." It has sought to avoid duplication of existing regional or international environ-

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1/ J. Barnes, Toxic Hazards of Certain Pesticides to Man (WHO Monograph Series No. 16, 1953).

2/ See, e.g., World Health Organization, Control of Pesticides: A Survey of Existing Legislation (1970) [hereinafter cited as WHO, Control of Pesticides].

3/ Codex Alimentarius Commission, Recommended International Maximum Limits for Pesticide Residues (5th ser. 1976).

mental programs and is currently studying various aspects of hazardous waste management, including the disposal of toxic chemicals.[1]

Because this effort by NATO does include recommendations for classification systems of hazardous wastes, a brief summary of this subject is in order.

In recognition of the growing importance of hazardous waste generation and disposal to environmental protecting and economic development, and considering that international cooperation could contribute effectively to a better understanding of the complex nature of the problems involved, the Pilot Study "Disposal of Hazardous Wastes" was originally proposed by the Federal Republic of Germany at the 1973 Fall CCMS Plenary. The proposal was made at a time when numerous environmentally unsound hazardous waste disposal activities were reported in most industrialized countries. There was an obvious need to improve the situation in that area. Governments of nearly all NATO countries recognized this challenge and responded by preparing or reviewing legislation and regulations to control the flow of hazardous wastes into the environment and to avoid further mismanagement. In this respect the proposed pilot study met special interest among NATO Allies.

Based on the results of a Group of Experts meeting, convened at Bonn in September 1973, the general objectives of the Pilot Study were defined as follows:

1/ North Atlantic Treaty Organization Committee on Challenges of Modern Society, Disposal of Hazardous Wastes, Final Report, No. 77, October, 1977.

-- to define and analyze technical, organizational and regulatory ways and means for the proper disposal of hazardous wastes

-- to compile and evaluate various management approaches to the solution of the hazardous waste problem

-- to draw conclusions from the previous analysis and work out recommended where possible

This Pilot Study was not limited to technologies and scientific problems as are many other CCMS projects. Basic policy issues of waste management also were discussed as were economic, legislative and regulatory aspects and measures as framework conditions for concrete actions in practice. In this way, the Pilot Study was able to analyze and clarify a great number of complex interrelations between technical and non-technical factors influencing the hazardous waste problem.

In the course of 1974 and 1975 the Pilot Study group selected specific problem areas for further discussion and agreed on a well defined working program. Six individual sub-projects were chosen:

-- landfill research and landfill practice

-- underground disposal

-- transportation

-- organization

-- recommended procedures for hazardous waste management

-- chromium cycle.

The hazardous waste categorization issues were addressed under the sub-project "organization". The conclusions reached were as follows:

> The classification of hazardous wastes is of importance for the organization of their disposal as a basis for planning and control

and the recommendations were:

> There are basically two regulatory approaches for establishing a country's classification of hazardous waste: the list approach (enumeration of types of wastes) and the criteria approach.
>
> Current hazardous waste lists are generally in a developmental stage of preparation. Although the methodologies differ to establish such lists,a considerable international consensus exists regarding which materials should be classified as hazardous under disposal aspects.
>
> Due to basic differences in hazardous waste management technology, political and economic structures of the various countries and the present lack of information on the properties of many wastes,an international hazardous waste list seems not yet feasible.

North Atlantic Treaty Organization (NATO) has undertaken preliminary survey of hazardous wastes classification schemes as these are practiced in NATO member countries. Summary of this effort is described in the following pages.

Statutory Definitions

During the last five years, all participating countries have recognized the hazardous waste disposal problem and a number of countries have passed legislation to cope with these potentially dangerous residuals. Exhibit 2, Statutory Definitions, highlights the wording of the basic waste management laws in several of the participating countries.

In general, one major theme pervades these statutory definitions. Harmful effects or pollution as the result of a disposal act are the major criteria. Both human health and the environment are specifically cited in France, the United Kingdom, and the United States as possible receptors of negative effects. The Germany and the United Kingdom wastes with potential hazard are considered "special wastes," and they are part of a larger statutory scheme requiring planning for and notification of actions relative to a wider range of wastes. In France, the FRG, Netherlands, the United Kingdom, and the United States, chemical, hazardous or special wastes must be or have been identified, and these wastes are subject to a broad system of regulations.

Thus, all countries begin from a relatively similar statutory basis as to what characteristics of wastes should be of concern. Words such as "noxious," "difficult", "dangerous", "detrimental", "injurious", "poisonous," "polluting", and "degrade", appear throughout the enabling legislation, It is clear that an international consensus exists that certain waste materials -- whether solid, liquid, sludge, or contained gas -- are capable of damage to the environment and public health and that controls on their ultimate disposition are required.

Hazardous Waste Definition

Central to any program to manage hazardous waste are the definitional limits on those waste materials controlled by the management system and those outside of it. These definitions

Statutory Definitions

France - . . . cateogires of waste may be defined by decree and the enterprises that produce, import, transport, or dispose of wastes which belong to these categories and which are in a state such that they cause, or at the time of their disposal may cause, a nuisance such as . . . injurious effects on the soil, plants, or animals, to degrade the scenery or the countryside, to pollute the air or water, to create a noise or door, or, . . . [are] harmful health or the environment . . . (Art. 8 and 2; Law No. 75-633; July 16, 1975).

Federal Republic of Germany - Special wastes are such wastes from commercial or trade companies which due to their nature, composition, or quantities are especially hazardous to human health, air, or water, or which are explosive, flammable, or may cause diseases. Their disposal must be subject to additional requirments according to the Act. (Federal Act on the Disposal of Waste, 1972, as amended, 1976).

Netherlands - Chemical wastes are: (1) wastes consisting wholly or partly of chemicals indicated by General Administrative Order and (2) wastes produced by chemical processes designated by General Administrative Order. (Chemical Waste Act, 1977).

United Kingdom - Waste "of a kind which is poisonous, noxious or polluting and whose presence on the land is liable to give rise to an environmental hazard." (Deposit of Poisonous Waste Act, 1972); Special wastes are those which "may be . . . dangerous or difficult to dispose of" (Control of Pollution Act, 1974).

Regulatory Definitions

Several of the member countries have submitted legislation, regulations, or hazardous waste classification schemes that have either been passed as law or are preliminary documents for establishment of their hazardous waste lists. Discussed below are the current classification systems for Denmark, the EEC, the Federal Republic of Germany, France, Netherlands, the United Kingdom, and the United States (California).

Denmark

A list of 39 chemical wastes had been written as of December, 1976. Two general criteria are given for the choice of wastes; they are: "1) being hazardous to the environment and people, and 2) arising in significant quantities."

The majority of entries on the list are industry- or process-specific wastes; the remainder are groups of chemical compounds. No individual hazardous chemicals are listed; i.e., the list is not a detailed one.

Federal Republic of Germany

In the Federal Republic of Germany a guideline "waste catalogue" has been in existence since 1975 containing all imaginable types of wastes. Some of the States (Lander) took various approaches to introduce a classification scheme from this general catalogue to separate out hazardous wastes by such schemes as: (1) choosing classes of hazard and noting minimum quantities of each waste class, (2) orienting hazardous wastes class to the kind of disposal procedures, and (3) choosing as "hazardous", wastes not suitably co-disposed with residential waste (based on operational and/or physical/chemical parameters of the waste). As a consequence, a waste considered could be a special waste in one State, but not another. Problems arose where waste producers were bound locally, but transportation and disposal facilities necessarily operated across State borders.

The Act for an amendment to the Waste Disposal Act (July 21, 1976) generally defines "special wastes" although the term is not mentioned in the definition: "Following the present law, disposal of wastes from commercial or trade companies which due to their nature, composition, or amount, are especially hazardous to human health, air, or water; which are explosive, flammable, or may cause contagious diseases, is subject to additional requirements." Wastes following the above definition are defined and listed by the Federal Government under consent of the Bundesrat (Federal Council) by means of regulation, which is effective as of June 1, 1977. The list will provide minimum, uniform standards for the Lander primarily with respect to waste stream control (notification, etc.).

The regulation includes a list of 35 types of waste streams (the so-called "hard core" of special wastes), and includes information on origin (manufacturing process) and major chemical constituents. One criterion for compiling the list is that quantity should be introduced into the classification by implication only; that an industry waste steam is listed should be sufficient to indicate which trades contribute wastes that contain significant enough amounts of a certain chemical that those wastes should be considered hazardous. (The purpose of this premise is to avoid over-control of industries that may produce an insignificant amount of substance that would only be considered hazardous in large amounts.)

Other criteria used for the establishment of this list were: (1) the special wastes identified in the Waste Catalogue by the Lander; (2) that the wastes not be chosen if they are compatible with domestic wastes for disposal or because their disposal may be technologically difficult; (3) the amount of chosen special wastes should possibly cover a major portion of the estimated 3 million tons of hazardous wastes generated in the Federal Republic of Germany annually. In summary then, the Federal Republic of Germany's hazardous waste identification scheme will consist of an industrial waste stream list chosen from the Waste Catalogue, to be implemented as a minimum list by all Lander.

France

Categories of waste may be "defined by decree" according to Title III, Article 8, of the Waste Disposal and Materials Recovery Law. "Waste" is defined in the General Provisions of the Law as "any material substance as a residue of a process of production, of transformation, or of utilization, or more generally, all moveable goods which have been abandoned or whose holder plans to abandon them." A draft Decree has been prepared that establishes five groups of these wastes; to be included is a list published pursuant to the provisions of Article L231-6 of the Labor Law.

The first category consists of chemical compound groups as well as a list of some 200 specific chemicals provided by the

Labor Law. The second category consists of radioactive-containing substances; the last three categories are comprised of selected industry-specific wastes. No particular criteria are set forth in the decree to explain the five categories of wastes.

Netherlands

The Chemical Waste Act which has passed Parliament refrains from defining the term chemical wastes, but calls for a List of Materials and a List of Processes to be established; the contents of both lists shall constitute "chemical waste," provided that certain concentration limits are exceeded. The List of Materials is comprised of elements and compounds whose concentrations are toxic or persistent to man, animals, or plants; the List of Processes is an industry-specific list of wastes which contains elements or compounds from the List of Materials.

The List of Materials is divided into four classes. Class A includes mercury, cadmium, and their compounds, and other compounds whose harmful effects on the environment are more or less comparable to mercury and cadmium. While toxic characteristics place some substances on the list, the properties of persistency and bioaccumulation make others hazardous to the environment. Thus, a low concentration of these materials (50 mg. per kg) in the environment makes them harmful due to these characteristics.

Class B is subdivided into groups BI and BII. The materials in BI are comparable heavy metal compounds whose harmful properties occur in higher concentrations of the compounds than in the metals of Class A; the concentration in which they are considered a chemical waste is higher, i.e., approximately 5000 mg/kg. Also included in group BI are organic compounds whose extraction, manufacture, or synthesis is industry-related. Polymerized compounds are not included in the group. Group BII covers elements or compounds that release acute volatile toxic materials when they contact water.

Class C is comprised mainly of inorganic materials whose compounds occur in 20,000 mg/kg. Some organic compounds with the same limitations as in Group BI are included in this class also.

Reactive elements and compounds (except for sulfur) that toxicologically are not so harmful make up Class D, as well as inorganic acids bearing corrosive properties (concentrations of 50,000 mg/kg).

Some compounds may fall into one or more groups under this system of classification. When such is the case, the lower concentration for the compound is taken as the upper permissible limit.

The Process List provides a complementary cross-index for the Materials List. For every waste that is included, the constituents of the waste are contained in the Materials List. The Process List contains an enumeration of several processes, and laboratories, which is expected to classify any new hazardous waste that might be produced, since new wastes can be expected to first come from a laboratory.

United Kingdom

The Control of Pollution Act of 1974, which applies to all wastes deposited on land, has given the Secretary of State the authority to establish regulations for the disposal of "special waste," which is defined as "'controlled waste' . . . that may be so dangerous or difficult to dispose of, that special provision . . . is required for the disposal of waste of that kind by disposal authorities . . ." (Section 17.1). Section 30.1 defines "controlled waste" as "household, industrial and commercial waste or any such waste."

Regulations and classification of special wastes have not yet been established; under consideration, however, is a preliminary List of Wastes Subject to Investigation. This list is comprised of 20 waste categories and their industrial origins. The criteria used to establish the list were to some extent "toxicity, polluting or other characteristics . . ." that ". . . might require special controls to be exercised or preferred methods of treatment and disposal recommended, depending on concentrations, circumstances, etc." Additionally, all wastes established by the Deposit of Poisonous Waste Act that are "poisonous, noxious, or polluting" will probably be classified as a Special Waste, excluding the exempted wastes of the Act.

A detailed categorization of "difficult wastes" has been published as well as a 12-category broader classification scheme. The Broad Classification of Wastes for Record-Keeping Purposes partly is a process-specific list, whereas the finely divided Classification of Difficult Wastes contains groups and subgroups of specific chemical compounds and groups of process-specific wastes and their subgroups. These lists have been provided for licensing and waste survey purposes only, so the United Kingdom official classification of "special wastes" is still to be established.

It appears that there are basically two regulatory approaches for establishing a country's classification of hazardous wastes -- the list approach and the criteria approach.

For all the waste schemes described, some criteria had to be used, whether formally or not, for the establishment of a list. Ideally, if the criteria for hazardous wastes were defined first, then there would be no question whether a substance were hazardous -- it would satisfy a crterion by passing a test. Thus, concentrations could be taken into consideration, rather than small amounts of a hazardous chemical constituent making a waste "hazardous." (as is implied by some definitions), although amounts of waste itself and circumstances are both relevant.

But these criteria tests bring up the problem of widespread sampling and analysis, which are not only very expensive, but also taxing on laboratory capacity -- especially on wastes which are of no value. Thus, the hazardous waste lists have evolved to eliminate some of these disadvantages.

The end result of the identification process has been a list of hazardous wastes, of some length, official or unofficial, for every country. The lists vary in detail from naming specific chemicals, to naming chemical compound groups, to identifying industry waste streams.

No one country used only one level of detail in their listing. Some use an industry-specific or process-specific classification system as a cross index to a chemical group listing and/or a specific chemical list (California, USA; Netherlands). Others use the industry waste-stream classification with the intent of establishing a more specific list in the future. Other countries use a combination of two or three systems of defining waste in one list (France, Denmark, EEC).

Tables 4B and 5B has been prepared to illustrate those wastes which three (or more) and five (or more) participating countries have in common according to their current lists of hazardous or potentially hazardous wastes. An "X" signifies that the particular country actually has such a waste cateogry; a "P" signifies that a country's category is only a part of the category in the left column or that the waste is considered hazardous under certain restrictions. It is interesting to note that the majority of classes that five or more countries have in common are those defined on the chemical-compound-group level.

The current hazardous waste lists are generally in a developmental and/or unfinished stage of preparation. Denmark has supplied a final list of wastes, but no criteria for selection were available for comparison. The EEC, while providing a list of chemical compounds to define Toxic and Dangerous wastes, also gives no criteria for the selection of the wastes. The list is by no means exhaustive when compared to the California, (USA), the UK, or the FRG lists, although it may be an important step as a common base for initial hazardous waste identification by the member countries.

The list provided by the Federal Republic of Germany has been officially passed as a bylaw. Two distinct advantages of the enacted system are (1) that Lander may declare additional wastes depending on local conditions, and (2) the quantity of waste does not play a direct role in the classification criteria.

The French regulation (decree) that has been drafted to define hazardous wastes also lacks any accompanying criteria utilized to establish the list. While the list of specific chemicals from the Labor Code is very detailed and extensive, the industrial-waste classification provided by the decree is not as comprehensive as the other countries' lists.

The Netherlands has passed regulations in fulfillment of legislation to establish an official hazardous waste list. While very general criteria are given for the establishment of their classification (persistency, toxicity, bioaccumulation), specific concentration levels calculated on a dry weight basis are spelled out in the regulations: 50-5000-20,500-50,000 mg/kg. The chemical compound classification is quite extensive, but not as explicit as California's List, which leaves no doubt in the producer's mind exactly which chemicals of a compound group are to be considered hazardous. The cross classification by means of a "process" list in the Netherlands seems to be an advantageous method of classification, lest the waste producer be unsure of the constituents of his waste.

The United Kingdom's preliminary list has also been provided without accompanying criteria. The country has established industry-related waste classes and intends to establish a detailed list of chemicals to accompany the first class. Also published in part by the UK is a series of Waste Management Papers which each give a detailed description for the treatment and disposal of particular wastes.

The fact that some countries have existing regulations for municipal or other non-hazardous waste disposal has a great deal to do with how far along they have come in developing lists of hazardous wastes. For example, in the United Kingdom a wide range of all wastes are "controlled" according to the Control of Pollution Act of 1974. Thus, the classification of "special wastes" can be a refinement of their total waste management system, such that the special wastes may be disposed in a safe manner.

The United States, on the other hand, is in the process of analyzing all solid waste, and at the same time preparing a hazardous waste classification scheme. Thus, Federal hazardous waste management regulation is just being introduced in a country where wastes were heretofore regulated by individual States.

Finally, the character of a country's classification system is not purely a function of the best technology available. Political and economic environments influence the technical considerations. For example, the extent to which industry or the public are accustomed and/or allowed to participate in the classification decisions can have a major impact on the final scheme.

In summary, there is not strict consensus as to the methodologies used to identify hazardous wastes due to the differing governmental decision-making processes. The results of the several methodologies when translated to lists do portray a number of similar concerns for several classes and types of wastes.

TABLE 4B

WASTES CONSIDERED HAZARDOUS OR POTENTIALLY HAZARDOUS BY THREE OR MORE COUNTRIES

	Denmark	EEC[1]	Federal Republic of Germany	France[1]	Netherlands	United Kingdom	California USA
Aluminum-Containing Waste	X		X	P	P	X	P
Antimony & Comounds		X		X	X	X	X
Arsenic & Compounds		X		X	X	X	X
Asbestos	X			X	X	X	X
Beryllium Waste		X	X	X	X	P	X
Cadmium Waste		X	X	X	X	X	X
Chlorine				X	X		X
Chromium III Waste	P			X	X		X
Chromium VI Waste	P	X	X	X	X	X	X
Copper Waste	X			X	X	X	X
Cyanide Compounds	P	X*	X	X*	X	X	X
Dye Manufacturing Waste	X		X		P	X	
Florine				X	X		X
Halogenated Solvents	X	P	X	X	X	X	X
Herbicides	X	X	X	P	X	X	P
Isocyanates	X	X		X	X	X	
Laboratory Waste		X		X	X		
Lead Waste	X	X	X	P	X	X	X
Magnesium Waste			X	P	X	X	X
Mercury Waste	X	X	X	X	X	X	X
Metal Surface Treatment Waste	X	X	X	X	P	X	X

TABLE 4B (Continued)

	Denmark	EEC[1]	Federal Republic of Germany	France[1]	Netherlands	United Kingdom	California USA
Nickel Waste	X			P	X	X	X
Non-Halogenated Solvents	X	P	X	P	X	X	X
Oil Refinery Waste	X		X	X	X	X	X
Organic Peroxides	X			P	X	X	
Paint Manufacturing Waste	X		X	X	P	X	X
Pesticides	X	X	X	P	X	X	X
Pharmaceutical Manufacturing Waste		X	X	X	X	X	X
Phenol-Containing Waste	X	X	X	X	X	X	P
Phytopharmaceutical Waste		X		X	X	X	
PCBs	X		X	X	X	X	X
Rubber Manufacturing Waste	X		X	P		X	
Silver-Containing Waste	X				X	X	X
Sulfur-Containing Waste	X		X	P	X	X	X
Thallium Waste		X		X	X		X
Vanadium & Compounds				X	X	X	P
White Phosphorous				X	X		X
Zinc Waste	X			X	X	X	X

TABLE 5B

WASTES CONSIDERED HAZARDOUS OR POTENTIALLY HAZARDOUS BY FIVE OR MORE COUNTRIES

	Denmark	EEC[1]	Federal Republic of Germany	France[1]	Netherlands	United Kingdom	California, USA
Aluminum-Containing Waste	X		X	P	X	X	P
Antimony & Compounds		X		X	X	X	X
Arsenic & Compounds		X	X	X	X	X	X
Asbestos	X		X	X	X	X	X
Beryllium Waste		X	X	X	X	P	X
Cadmium Waste		X	X	X	X	X	X
Chromium VI Waste	P	X	X	X	X	X	X
Copper Waste	X			X	X	X	X
Cyanide Compounds	P	X*	X	X*	X	X	X
Halogenated Solvents	X	P	X	X	X	X	X
Herbicides	X	X	X	P	X	X	P
Isocyanates	X	X		X	X	X	
Lead Waste	X	X	X	P	X	X	X
Mercury Waste	X	X	X	X	X	X	X
Metal Surface Treatment Waste	X	X	X	X	X	X	X
Nickel Waste	X			P	X	X	X
Non-Halogenated Solvents	X	P	X	P	X	X	X
Oil Refinery Waste	X		X	X	X	X	X
Paint Manufacturing Waste	X		X	X	P	X	X
PCBs	X		X	X	X	X	X
Pesticides	X	X	X	P	X	X	X
Phenol-Containing Waste	X	X	X	X	X	X	P

*excluding ferro- and ferri-cyanide

TABLE 5B

	Denmark	EEC[1]	Federal Republic of Germany	France[1]	Netherlands	United Kingdom	California, USA	
Sulfur-Containing Waste	X		X	P	X	X	X	
Zinc Waste	X			X	X	X	X	

International Agency for Research on Cancer (IARC)

In the early 1960s, a group of French researchers proposed the establishment of an international cancer research organization, to be funded by an appropriation of one-half of one percent of the military budget of the nations of the world. Shortly thereafter, in 1965, the Eighteenth World Health Assembly established the International Agency for Research on Cancer (IARC) within the overall framework of the World Health Organization. IARC is based in Lyon, France, and has additional research centers in Nairobi, Singapore, and Jamaica. It has an annual budget in excess of six million dollars, and has collaborated with WHO in drawing up a broadly based long-term plan for international coopeation in cancer research, largely modeled on the programs of the U.S. National Cancer Institute and the Council for Mutual Economic Assistance (COMECON).

IARC has sought not to duplicate the work being performed by national institutions, although international coordination of these activities is an important aspect of its work. Much of its research efforts have been focused upon environmental carcinogenesis, a field which it considered to be "inadequately developed at the national level, and (where) an international research program with a coordinated multidisciplinary laboratory and epidemiological approach" would be of great value.

In 1967, IARC commenced its program to study chemical carcinogenesis with research on the effects of DDT upon animials. Since that time, four different aspects of the program have been developed: the collection of carcinogenicity data in a series of monographs on the evaluation of the carcinogenic risk of chemicals to man; the evaluation of the significance for man of experimental data; the long-term testing of environmental chemicals which are of particular socio-economic importance; and the development of rapid screening tests for potential chemical carcinogens.

The objective of the series of monographs is to provide government authorities with expert, independent, scientific opinion on environmental carcinogenesis, by assembling all available data and evaluating it in terms of possible human risks. To overcome many of the difficulties inherent in the evaluation of diverse sources of technical, experimental, and epidemiological data, IARC establishes "working groups" of international experts who serve in individual, rather than official, capacities. Their published reports do not include recommendations for preventive or legislative measures. Such matters are considered to be decisions most appropriately made on the basis of risk-benefit assessments by individual governments and/or broadly based international agencies.1/ By the end of 1976, working groups had

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1/ International Agency for Research on Cancer, Some Carbamates, Thiocarbamates and Carbazides 9 (IARC Monograph on the Evaluation of Carcinogenic Risk of Chemicals to Man No. 12, 1976) screened all relevant epidemiological, experimental, production, and occurrence data for a total of 296 chemicals. Unequivocal or strong circumstantial evidence of carcinogenicity to animals and/or man was found for 163 of the 296.[1]

IARC has already undertaken a number of surveys to ascertain the nature and extent of carcinogenicity testing being carried out by individual institutes or agencies around the world.[2] It also serves as the Secretariat for the International Association of Cancer Registries, which was established in 1969. The Association publishes standardized cancer incidence figures from approximately eighty population groups collected by registries in twenty-eight countries.

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[1] An analysis of the evaluations of substances made by working groups is as follows: Chemicals evaluated - 296; Chemicals carcinogenic to man - 20; Chemicals definitely carcinogenic in experimental animals only - 143; Chemicals for which data were inadequate for evaluation or indicated a possible carcinogenic effect - 110; Chemicals for which the available data did not reveal a carcinogenic effect - 23. This information is based on summaries of data reported in the first 12 volumes of the IARC Monographs on the Evaluation of Carcinogenic Risk of chemicals to Man. See IARC Report, supra note 6, at 86; Some Carbamates, Thiocarbamates, and Carbazides.

[2] Int'l Agency for Research on Cancer Information Bull., March 1976 at 6. The survey covers information from 89 institutes in 19 countries, and includes a total of 828 chemicals.

The International Register of Potentially Toxic Chemicals (IRPTC) 1/

A development with great potential for rectifying many of the problems of international chemical regulation is the proposal to establish, under the auspices of the United Nations, a register of all chemicals which have been objectively assessed to possess either toxic, or potentially toxic properties.

The International Register of Potentially Toxic Chemicals (IRPTC) had its genesis in a suggestion by the Scientific Committee on Problems of the Environment (SCOPE) 2/ in preparation of the United Nations Conference on the Human Environment, held in Stockholm in 1972. The proposal to establish an International Registry of Data on Chemicals in the Environment was endorsed by the Conference as part of what later became the Earthwatch program. It was to be based on "a collection of available

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1/ Information in this section relating to the proposed format of IRPTC is taken from the following sources: United Nations Environmental Program, Report of Expert Workshop on an International Register of Potentially Toxic Chemicals (Bilthoven, Netherlands, Jan. 6-11, 1975), U.N. Doc. UNEP/WG 1/4Rev. 1 [hereinafter cited as Bilthoven Report]; Task Team on the International Register of Potentially Toxic Chemicals, Report of the Task Team (Nairobi, July 28-Aug. 9, 1975) (unpublished UNEP document) [hereinafter cited as Nairobi Report]; The International Register of Potentially Toxic Chemicals, supra note 1; The International Register of Potentially Toxic Chemical Facts, Sept. 1976.

2/ SCOPE is a Committee of the International Council of Scientific Unions. At about the same time as the SCOPE suggestion, the U.N. Advisory Committee on the Application of Science and Technology to Development (ACAST) also considered the establishment of such a Register, Tenth Report of ACAST, 55 U.N. ESCOR, Supp. (No. 6) para. 48, U.N. Doc. E/5288 (1973).

scientific data on the environmental behavior of the most important man-made chemicals and containing production figures of the potentially most harmful chemicals, together with their pathways from factory via utilization to ultimate disposal or recirculation."

The Stockholm Conference focused the attention of the subsequently established United Nations Environment Program (UNEP) on a variety of urgen concerns ranging across the entire international environmental spectrum. However, the records of UNEP's governing council indicate that member governments have attached an especially high priority to the establishment of IRPTC.[1] As a result, considerable progress has been achieved despite the magnitude of the proposed undertaking.

An international workshop held at Bilthoven, in the Netherlands, in January, 1975, recognized the difficulties inherent in attempting to assemble the information required:

> Data on properties may be separated from biological effects data. The use of trade names makes it difficult to associate commercial products with toxicological data. Negative results of toxicological tests are often not reported at all. Information on production and use, if it exists, is not associated with scientific data. Moreover, the existing data are often found in forms that are utilizable by decision-makers.

While the ultimate objective of IRPTC is to reduce the health and environmental hazards presented by chemicals, its immediate aim is to facilitate universal access to existing scientific and regulatory data. IRPTC proposals make little distinction between problems of short-term acute toxicity and longer-term toxicity.

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[1] See Report of the Second Session of the Governing Council of UNEP, 29 U.N. GAOR, Supp. (no. 25) 59, UN.M. Doc. A/9625 (1974). See also Report of the Fourth Session of the Governing Council of UNEP, 31 U.M. GAOR, Supp. (No. 25) Decision 52(IV), para. 125, U.N. Doc. A/31/25 (1976).

The Bilthoven Workshop rejected the possibility of establishing a single, all-embracing, central register, and opted instead for a decentralized system consisting of a network of cooperating data collection points and a "central unit." The latter will coordinate the use of information held by network partners and will maintain its own files identifying all chemical substances and the sources where relevant information can be obtained. The central unit will also provide a mechanism for the review of the quality of the data and the overall functioning of the system. In addition, each participating country will be required to nominate a specific individual, or institution, as the IRPTC national correspondent. By the end of 1976, the organizational headquarters had been established in Geneva and a variety of preliminary projects had been undertaken.

In practice, IRPTC will be closely linked to the two other major components of the UNEP Earthwatch program -- the International Referral System (IRS) and the Global Environmental Monitoring System (GEMS). It is GEM's responsibility to monitor the presence of various chemicals in the environment. Relevant information gathered by GEMS at its monitoring stations will be incorporated into the Register and, in the absence of adequate information on a particular chemical, a specific GEMS monitoring program will be sought. IRS is founded on a network of national and international focal points and seeks to provide a world-wide exchange of sources of environmental information. IRPTC will be involved only with specific substance-oriented inquiries. General chemical information that is unsuitable for IRPTC will be retained by IRS. In addition to its efforts to coordinate its work with UNEP, IRPTC will seek to collaborate with the multiplicity of United Nations agencies and outside groups working in the chemical field.

The Organization for Economic Cooperation and Development OECD 1/

To date, OECD has achieved a greater degree of international environmental cooperation than any other international group. Since the establishment of its Environment Committee in 1970, OECD has effectively promoted the acceptance of the "polluter

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1/ OECD was established in 1960 and its current membership includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, the Federal Republic of Germany, Greece, Iceland, Italy, Japan, Luxemburg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. Organization for Economic Cooperation and Development, OECD and the Environment 4 (1976) [hereinafter cited as OECD and the Environment].

pays principle," produced a major "Declaration on Environmental Policy," and specifically focused upon the issue of chemicals in the environment. In many of its endeavors, the organization has worked in cooperation with the specialized agencies of the United Nations and the European Economic Community. Perhaps its most tangible achievement to date has been to restrict the manufacture and use of polychlorinated biphenyls (PCBs) to use for very specific purposes in all twenty-four of the OECD nations.[1]

At the first ministerial level meeting of the OECD Environment Committee,[2] in November, 1974, the OECD Council recommended: (1) that data relating to the manufacture, import, and sales of chemicals be collected; (2) that procedures be developed to facilitate the assessment of potential environmental effects of chemicals; and (3) that the effects of chemicals on humans and the environment be assessed prior to marketing.[1] The major objective of the recommendation is to stimulate a concerted approach by member countries to prevent the unintentional environmental ill-effects of chemicals.

1/ OECD Council Decision, Protection of the Environment by Control of Polychlorinated Biphenyls (Feb. 13, 1973), reprinted in id. at 17-19. The Council resolved that the use of PCBs "should be controlled by international action in order to minimize their escape into the environment pending the realization of the ultimate objective of eliminating entirely their escape into the environment." Id. The decision was unanimous, and has since been adopted in national legislation in all member countries.

2/ The governing body of the OECD, the Council, is assisted in its work by a number of specialist committees covering such areas as Economics Policy, Development Assistance, Technical Cooperation, and the Environment. These committees may, in turn, establish even more specialized groups such as the Chemicals Group. The (Continued on next page)

As part of its 1974 resolution, the OECD Council also directed its Environment Committee to consider methods designed to achieve "greater collaboration and harmonization in respect of national assessment" of chemicals. As a result, the OECD Chemicals Group has recently considered a set of draft "Guidelines in Respect of Procedure and Requirements for Anticipating the Effects of Chemicals on Man and in the Environment."[1] If adopted by the full Council, the guidelines will represent a major step towards the extension of regulatory measures from certain product groups to chemicals in general and the coordinated consideration of environmental and human health factors. The draft urges member

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(Continued from previous page)
Council, which may meet at the ministerial or official level, usually acts unanimously and can make decisions that are binding on member states. See A. Robertson, European Institutions: Co-Operation, Integration, Unification 79-84, (2d ed. 1966).

[1] OECD Council Recommendations, The Assessment of the Potential Environmental Effects of Chemicals, reprinted in OECD and the Environment, supra note 110, at 37.

[1] Draft recommendation of the Council Establishing Guidelines In Respect of Procedure and Requirements for Anticipating the Effects of Chemicals on Man and in the Environment, OECD Doc. ENV/Chem./76.13 Rev. (1976) [hereinafter cited as Guidelines]. The draft guidelines were endorsed in principle by all delegates to the Environment Committee's Chemicals Group meeting in October, 1976. Final approval was withheld until the Chemical Group's next meeting. It must be emphasized, therefore, that the guidelines discussed in the text are only in draft form and have not yet been considered by the full Council of OECD. Nevertheless, in view of the significance of the proposal, the approach seems to be sufficiently well settled to warrant analysis.

countries to take the guidelines into account in establishing new procedures, or extending existing procedures, for assessing the effects of chemicals.

The guidelines represent an attempt to establish a common denominator for chemical regulation acceptable to countries at significantly different stages of economic development. At one point, the draft specifies examples of different regulatory options which may be adopted involving different degrees of stringency and implementation costs.[1]

At the same time, the guidelines attempt to reconcile disparate national approaches to the assessment and introduction of new chemicals. The draft notes that the economic and technical resources available for assessment procedures are limited and, accordingly, recommends that assessment priority be given to: (1) new chemicals; (2) existing chemicals being used for distinctly new purposes or in considerably increased quantities; and (3) existing chemicals that are newly suspected of being harmful to health or the environment. It suggests that a two-phase approach be adopted in the assessment of chemicals. The first assessment would seek to determine the general likelihood of health and environmental hazards presented by a chemical. Suggested basic data requirements for this stage of assessment are included in the guidelines. The second phase involving more detailed and intensive testing programs, is to be undertaken where the initial assessment indicates that a substance is hazardous to human health or the environment.

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[1] Id. para. 15. Three progressively stringent regulatory options are suggested in the draft. First, a nation may simply require a manufacturer to make available to national authorities, upon request, the results of the evaluation of new chemicals. Second, manufacturers and importers may be required to provide automatically to national authorities information on the product name, the projected quantities to be produced or imported, and the intended use for each new chemical. Third, manufacturers and importers may be required to supply national authorities with all information necessary for an initial assessment of every new chemical product, so that the authorities have enough data to determine whether to test and/or regulate the use of the new substance. Id.

The guidelines do not establish a comprehensive mechanism for international cooperation in the conduct of assessment procedures, nor is there any attempt to standardize the evaluative criteria to be applied to chemical substances. However, they do urge the establishment of an integrated approach to assessment "with optimum co-ordination between expert groups established under different authorities." Moreover, the draft recommendation proposes that OECD instruct its Environment Committee "to pursue a program of work designed to facilitate the practical implementation" of the guidelines "with particular attention to the need for further development and improvement in respect of experimental techniques."

The OECD guidelines are the outcome of prolonged negotiations among member governments and represent a major step towards effective international regulation of chemicals. The guidelines are of particular significance in that they are applicable to all chemical substances, regardless of intended use, and they ensure that environmental, as well as health factors will be assessed.

Within the ongoing work program of the Organization for Economic Cooperation and Development (OECD) Chemicals Groups, a Chemicals Testing Program was established in November 1977, in order to develop consistent data requirements and testing methods. The Program comprises six expert groups under the leadership of six OECD member countries.

Five groups are preparing reports on test methods that can be used in practice to predict the effects of chemicals and to identify their properties. A sixth group is considering the concept of step-sequence testing systems, including the baseline set of data required for an initial assessment of potential effects.

The Chairman of the Expert Groups forms a Coordinating Group which provides a liaison between the Expert Groups and the Chemicals Group. This ensures that duplication is avoided and that the program proceeds on schedule. Within the given time frame, these Groups will jointly prepare state-of-the-art reports on test methods that can be used to provide information on:

- physical-chemical properties of chemical substances (Physical-Chemistry Group; lead country - Germany).
- effects from chemical substances on biotic systems other than man (Ecotoxicology Group; lead country - Netherlands).
- degradation-accumulation of chemical substances (Degradation/Accumulation Group; lead country - Japan/Germany).
- short-term effects of chemical substances on human health (Short-Term Toxicology Group; lead country - UK).
- long-term effects of chemical substances on human health (Long-Term Toxicology Group; lead country - USA).

- the concept of step-sequence testing systems (Step Systems Group; lead country - Sweden).

Recently, a "Special Program on the Control of Chemicals" has been initiated within the OECD Chemicals Program. This program, which will be financed separately by the participanting member countries and the Commission of the European Communities (CEC), aims to achieve international cooperation in the control of chemicals, and to facilitate the acceptability of data between Member countries. Specifically, this will include developing:

- consistent standards for good laboratory practice (effective means to enforce them may be considered at a later stage)
- solutions to confidentiality of data both to ensure international exchange of health and safety data and to provide adequate protection for legitimate trade secrets.
- mechanisms to facilitate information exchange both with respect to substance-related data and to administrative actions.
- an agreed international glossary of key terms.

In order to coordinate ongoing programs and to prevent duplication of efforts, information exchange is conducted through the participation of representatives of the Commission of the EEC in the various OECD-Chemicals Expert Groups, and in the Special Program on the Control of Chemicals. The Commission has additionally organized two information meetings with representatives of the U.S. Environmental Protection Agency (EPA), at which the comparability of test methodologies for chemicals was discussed, and the necessity of intercalibration tests to assure the quality of data was stressed.

Established in 1962, the Business and Industry Advisory Committee for OECD (BIAC) provides industrial advice and expertise for activities within OECD. Structured similarly as OECD, International BIAC is composed of national branches in each of the 24 OECD Member countries.

The European Economic Community (EEC)

The European Economic Community is a nine-member group of countries[1] which seeks to improve living and working conditions in member nations through the elimination of national trade barriers, wherever practicable. In seeking to promote the removal of national trade barriers, the Treaty of Rome enables EEC to harmonize anti-pollution and other standards for specific products. Thus, in 1967, the EEC Council approved an initial directive relating to the classification, packaging, and labeling of dangerous substances.[2] The directive was modest in its scope and limited in its environmental significance, concerning itself principally with better informing the public of the nature of dangerous substances, and protecting the work force involved in the production and distribution of such substances.[3]

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[1] The member countries are Belgium, Denmark, France, the Federal Republic of Germany, Ireland, Italy, Luxemberg, the Netherlands, and the United Kingdom.

[2] Council Directive of 27 June 1967, No. 67/548/EEC, 10 J.O. Comm. Eur. (No. 196) 1 (1967). The directive has been modified on five occasions, the most recent being by Council Directive No. 75/409/EEC, 18 O.J. Eur. Comm. (No. L 183)22(1975).

[3] The limited scope of the initial directive partly reflected the fact that, until 1971, environmental protection was considered to be primarily a matter of national, rather than EEC concern.

In March, 1973, the governments of the member states agreed to notify the Commission of proposed national environmental legislation that affected EEC's environmental program, or was of particular interest to EEC.[1] Member states which proposed the enactment of new legislation agreed to temporarily defer the measures in order to provide the Commission with an opportunity to consider Community-wide legislative action. The agreement provided an exception for national measures which are "urgently necessary for serious reasons of safety or health."

In November, 1973, the Council approved the principles and objectives of an EEC environmental policy in the form of a "Declaration Concerning the Program of Action of the European Communities on the Environment."[2] The program endorsed the principle of internalizing pollution costs through application of the "polluter pays principle," and proposed the development of scientific criteria to measure objectively the extent and cost of pollution damage. More specifically, it sought to encourage the improvement and harmonization of quantitative analysis techniques, the promotion of investigations into the long-term toxicity effect of certain substances, and the standardization of toxicity tests.

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[1] Council Agreement of 5 March 1973 on Information for the Commission with a View to Possible Harmonization Throughout the Community of Measures Concerning the Environment, 16 O.J. Eur. Comm. (No. C9)1(1973).

[2] Council Declaration of 22 November 1973, 16 O.J.Eur.Comm. (No. C112)1(1973).

In June 1975, the French government, in accordance with EEC information agreement of March, 1973, notified the Commission of its intention to adopt legislation controlling the dispersal of chemical substances in the environment. The Commission subsequently invited the French authorities to postpone the application of the proposed measures so that proposals for joint EEC action could be prepared. The outcome was a proposed directive which is currently before the Commission. The proposed directive seeks to substantially amend the 1967 directive relating to the classification, packaging, and labeling of dangerous substances. Although the proposal is legally characterized as an amendment, it is, in fact, substantially more signficant than a mere "technical amendment" of an existing directive. Thus, it must be examined by the Council following its consideration by the Economic and Social Committee and the European Parliament.

The major thrust of the proposed directive is to expand the scope of the 1967 directive by requiring that, prior to marketing any new substance, a thorough assessment of the effects on man and the environment be undertaken and submitted to the relevant national authority. If endorsed by the Council in its present form, the directive will identify those characteristics of the substance that must be investigated and reported. Important characteristics to be included in the investigation are the direct, or indirect, risks to man and the environment arising from the various possible uses of the substances. Manufacturers also would be required to provide notification of any new data or other relevant changed circumstances, such as new uses or substantial increases in marketed quantities.

A second significant aspect of the proposed directive is that it contains explicit criteria for identifying and classifying chemicals into certain groups according to their effect on man and the environment. Article 2 of the existing directive classifies substances and preparations as toxic, harmful, or corrosive on the basis of general definitions. However, the present directive fails to establish specific standards for determining whether a substance falls within the general definitions. Therefore, the proposed directive amends Article 2 to specify precise criteria by which a substance is to be classified, and adds a new category of substances deemed to be "dangerous for the environment."

The provisions of the proposed directive are compatible with OECD's draft guidelines for anticipating the effects of chemicals on man and in the environment.

Other initiatives of EEC are also worthy of note. EEC's Joint Research Centre in Ispra, Italy, is currently engaged in establishing an Environmental Chemicals Data and Information Network which is conceptually similar to the more comprehensive IRPTC. The extent of potential overlap between the two programs is unclear at this stage. The Network's major objective is to facilitate access by national authorities to the multiplicity of sources of information on chemical substances which are presently scattered throughout the European Community. In addition to this project, the Commission is presently considering a number of other proposals indirectly relating to the regulation of toxic chemicals.

ECDIN (Environmental Chemicals Data and Information Network)

The ECDIN project is carried out partly at the Ispra Establishment of the Commission of the European Communities' Joint Research Centre, which is located in northern Italy, and partly through contract research in Universities and other institutions whose funding is shared between the national governments of the EC member states and the Commission itself within the framework of the Indirect Action research program on the environment.

ECDIN is conceived primarily as a tool for the provision of reliable information on environmentally significant chemical products to all people engaged in environmental management and research. It has, however, a potential role as an information management facility for those concerned in protecting the environment. The potential is already being realized by the use of the ECDIN system for the preparation of a European Inventory of Existing Commercial Chemical Substances (EINECS) in the context of the sixth amendment of 1967 directive on labelling, packaging and classification of dangerous substances. When completed, EINECS will be used to determine whether a substance to be placed on the market is new, in which case the notification procedure of the sixth amendment will have to be followed.

The basic principle of ECDIN is to store relevant information on a chemical produced in sizable quantities regardless of the form in which it is used, its intended function or its presumed degree of "harmlessness". It is difficult at present to define "sizable" but an annual production figure of 500 kg has been selected as the limit above which a compound should be "stored" in the system. Moreover, all chemicals having a high toxicity, although produced in small quantities, and selected toxic natural products, for instance aflatoxins, should be included. Also included will be degradation products, metabolites and by-products in the manufacture, of the above chemicals. It has been estimated that eventually some 20,000 to 30,000 chemicals will be included in the system. This figure may have to be revised upwards in view of the number of substances listed in the TSCA Initial Inventory and First Supplement (46,000). Some mixture, groups of compounds and compounds of unknown or variable composition will also be included when information on specific defined substances is not available or has been aggregated for reasons of confidentiality.

More than 100 data fields have been identified as being relevant to the task of controlling environmental chemicals, and, during the ECDIN pilot phase, thought has been given to the design of formats for the representation of the data in each of these data fields. The data categories covered by the ECDIN project are shown in Table 6B.

TABLE 6B

ECDIN DATA CATEGORIES

1. Chemical Nomenclature and Other Identifiers
2. Chemical Structure Information
3. Physical and Chemical Properties
4. Chemical Analysis Data and Methods
5. Supply, Production and Trade
6. Transport, Packaging, Handling, Storage, Hazards
7. Use and Disposal
8. Dispersion and Transformation-Effect of the Environment on the Chemical
9. Effects of the Environment - Effect of the Chemical on Man and the Environment
10. Regulatory Data
11. Occupational Health

A number of user studies have been conducted and the results used to refine the design for ECDIN. Some of the questions posed to ECDIN during user studies are shown in Table . While it is recognized that in an operational system many questions are likely to be chemical compound oriented (i.e., asking for information about a specific compound), the system is also being designed to answer questions concerning identification of compounds having specified properties (e.g. which compounds used as anti-oxidants in the European Community have a specified level of toxicity when orally administered to rats?). The wide range of data being stored in ECDIN will allow questions to be answered which cannot easily be posed to other systems. Further, the ability to search for a compound by any known name and to display its chemical structure diagram differentiates ECDIN from other data banks.

A decision on the future of the ECDIN project is likely during 1980. The present pilot phase, which is essentially a research project on environmental chemical data banks, will then be gradually converted into an operational system. During the transition to an operational system, emphasis would first be given to the needs of the Services of the Commission. Priority will be given to data collection for substances covered by EC directives (covering dangerous substances, wastes, etc.) although effort will continue on the incorporation of existing data files into the data bank whether the substances concerned are coverted by directives or not.

TABLE 7B

SAMPLE QUESTIONS SUBMITTED TO ECDIN DURING A RECENT USER STUDY

- What information is available on the carcinogenicity of chemicals with epoxide ring structure?
- What is the recommended disposal method for tetraethyl lead?
- What is the toxicity of ethylene dibromide to animals?
- What is the solubility of DDT in water and what is its saturation vapor pressure?
- What is the world production of Freon 11?
- What regulations or codes of practice exist for the carriage of liquid chlorine by road and rail?
- What information is available on the environmental effects of chlorofluorocarbons?
- What substances are permitted in pressure sensitive adhesives for food contact use in the USA?
- What information is held about brick kilns in relationship to organic compounds and atmospheric contamination?
- Which governments have laid down regulations on the levels of heavy metals in foodstuffs?

ECDIN has been conceived as a network from the outset of the project. In an operational phase it is likely, however, that two networks would exist: an input network consisting of specialized institutes having existing data files, bibliographical systems or expertise in one of the fields covered by ECDIN and a telecommunications network (EURONET) for remote access to the data bank. It is not excluded that complete or partial copies of the data base will be made available for local searching to national focal points or international systems such as IRPTC. The ECDIN central unit in Ispra, whose main role would be the construction of the data base and coordination of the input, would also provide a limited search service largely for the Commission itself.

As already mentioned earlier, ECDIN is however potentially more than just an information service. Using the power of the ADABAS data base management system, ECDIN could provide an information management facility for the administrators in the Commission and in national governments concerned with environmental management.

Although the present ECDIN research project is likely to end this year, research will continue in JRC Ispra on the development of techniques for using the data stored in the data bank. Research topics are likely to include:

(a) establishment of priorities for testing chemical substances based on "exposure" criteria

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1/ Quantitative Structure Activity Relationships.

(b) prediction of the toxicity of new substances (by extension of QSAR 1/ techniques used in the design of pesticides and drugs).

The continued association between the developers of the system, researchers who will be developing the project further, and subject specialists in the specialized institutions who will be network partners will strengthen the project as a whole.

The Council of the European Communities has also established a directive as of September 18, 1979 which in Article 2 describes and categorizes so-called substances and preparations which are dangerous within the meaning of the directive issued by the Council of European Communities.

Table 8B below provides characteristics of dangerous substances.

The Council of European Communities does not classify the dangerous substances in terms of degree of risk involved. Rather Article IV of the Council's directive states the following: "the classification of dangerous substances according to the degree of hazard and to the specific nature of the risks involved shall be based on the categories laid down in Article II (Article II is presented in its entirely below). For categories A through J the substances shall be classified according to the greatest degree of hazard.

TABLE 8B

CLASSIFICATION OF DANGEROUS SUBSTANCES
EUROPEAN COMMUNITIES

Categories	Substance
R 1	Explosive when dry.
R 2	Risk of explosion by shock, friction, fire or other sources of ignition.
R 3	Extreme risk of explosion by shock, friction, fire or other sources of ignition.
R 4	Forms very sensitive explosive metallic compounds.
R 5	Heating may cause an explosion.
R 6	Explosive with or without contact with air.
R 7	May cause fire.
R 8	Contact with combustible material may cause fire.
R 9	Explosive when mixed with with combustible material.
R 10	Flammable.
R 11	Highly flammable.
R 12	Extremely flammable.
R 13	Extremely flammable liquefied gas.
R 14	Reacts violently with water.
R 15	Contact with water liberates highly flammable gases.
R 16	Explosive when mixed with oxidizing substances.

TABLE 8B (Continued)

Categories	Substance
R 17	Spontaneously flammable in air.
R 18	In use, may form flammable/ explosive vapour-air mixture.
R 19	May form explosive peroxides.
R 20	Harmful by inhalation.
R 21	Harmful in contact with skin.
R 22	Harmful if swallowed.
R 23	Toxic by inhalation.
R 24	Toxic in contact with skin.
R 25	Toxic if swallowed.
R 26	Very toxic by inhalation.
R 27	Very toxic in contact with skin.
R 28	Very toxic if swallowed.
R 29	Contact with water liberates toxic gas.
R 30	Can become highly flammable in use.
R 31	Contact with acids liberates toxic gas.
R 32	Contact with acids liberates very toxic gas.
R 33	Danger of cumulative effects.
R 34	Causes burns.
R 35	Causes severe burns.
R 36	Irritating to eyes.

TABLE 8E (Continued)

Categories	Substance
R 37	Irritating to respiratory system.
R 38	Irritating to skin.
R 39	Danger of very serious irreversible effects.
R 40	Possible risks of irreversible effects.

Source: Official Journal of the European Communities, Volume 19, No. L 360, 30 December, 1976.

The following substances and preparations are "dangerous" within the meaning of this Directive:

(a) explosive: substances and preparations which may explode under the effect of flame or which are more sensitive to shocks or friction than dinitrobenzene;

(b) oxidizine: substances and preparations which give rise to highly exothermic reaction when in contact with other substances, particularly flammable substances;

(c) extremely flammable: liquid substances and preparations having a flash point lower than 0°C and a boiling point lower than or equal to 35°C;

(d) highly flammable:

- substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any application of energy, or
- solid substances and preparations which may readily catch fire after brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition, or
- liquid substances and preparations having a flash point below 21°C, or
- gaseous substances and preparations which are flammable in air at normal pressure, or

- substances and preparations which, in contact with water or damp air, evolve highly flammable gases in dangerous quantities;

(e) flammable: liquid substances and preparations having a flash point equal to or greater than 21°C and less than or equal to 55°C;

(f) very toxic: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may involve extremely serious, acute or chronic health risks and even death;

(g) toxic: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may involve serious, acute or chronic health risks and even death;

(h) harmuful: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may involve limited health risks;

(i) corrosive: substances and preparations which may on contact with living tissue, destroy them;

(j) irritant: non-corrosive substances and preparations which, through immediate, prolonged or repeated contact with the skin or mucous membrane, can cause inflammation;

(k) dangerous for the environment: substances and preparations the use of which presents or may present immediate or delayed risks for the environment;

(l) carcinogenic: substances or preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce cancer in man or increase its incidence;

(m) teratogenic;

(n) mutagenic.

European Communities have also established data base with regard to the substances which when combined result in hazard. These are presented in Table 9B.

TABLE 9B

COMBINATION OF DANGEROUS SUBSTANCES (COMBINATION OF R-PHRASES) AND INDICATED RESULTS

R 15/29	Contact with water liberates toxic, highly flammable gas.
R 20/21	Harmful by inhalation and in contact with skin.
R 21/22	Harmful in contact with skin and if swallowed.
R 20/22	Harmful by inhalation and if swallowed.
R 20/21/22	Harmful by inhalation, in contact with skin and if swallowed.
R 23/24	Toxic by inhalation and in contact with skin.
R 24/25	Toxic in contact with skin and if swallowed.
R 23/25	Toxic by inhalation and if swallowed.
R 23/24/25	Toxic by inhalation, in contact with skin and if swallowed.
R 26/27	Very toxic by inhalation and in contact with skin.
R 27/28	Very toxic in contact with skin and if swallowed.
R 26/28	Very toxic by inhalation and if swallowed.
R 26/27/28	Very toxic by inhalation, in contact with skin and if swallowed.
R 36/37	Irritating to eyes and respiratory system.
R 37/38	Irritating to respiratory system and skin.
R 36/38	Irritating to eyes and skin.
R 36/37/38	Irritating to eyes, respiratory system and skin.

Source: Official Journal of the European Communities, Volume 19, No. L 360, 30 December, 1976.

APPENDIX C

HAZARDOUS WASTE CATEGORIZATION BY INTERNATIONAL NON-GOVERNMENT ORGANIZATIONS

Introduction

Several international non-government organizations have attempted to categorize hazardous wastes and/or substances. The following sections provide a summary review of these efforts.

Scientific Committee on Problems of the Environment (SCOPE)

As a component of the International Council of Scientific Unions (ICSU), the objective of the Scientific Committee on Problems of the Environment (SCOPE) is to promote interdisciplinary) collaboration among various unions, and to serve as a non-governmental source of advice on environmental problems. One of SCOPE's current projects is concerned with the toxic effects of chemicals on living organisms, especially on populations and communities within defined ecosystems.

Presently, in collaboration with the WHO, SCOPE plans to establish a continuous international forum with the purpose of developing internationally accepted methodologies for the safety evaluation of chemicals, both with respect to human health and to the non-human environment. This proposed group of recognized scientific experts will be limited in membership and terms of service, and will take into account geographical representation, as well as the affiliation of the experts (universities, government and industry). Meeting one or two times per year, this group will discuss, examine and develop the scientific and technical criteria of test methods used for the safety evaluation of chemicals.

The International Commission for the Protection Against Environment Mutagens and Carcinogens (IC-PEMC)

This organization was founded in 1977, and it is affiliated with the International Association of Environmental Mutagen Societies and is sponsored by the Instutute de la Vie. Representing a group of scientists from academia, research institutes and industry, the objective of ICPEMC is to identify and promote scientific studies in the fields of environmental mutagenesis, carcinogensis and genetic toxicology.

The International Academy for Environmental Safety (IAES)

IAES was established in 1971. It sponsors scientific meetings concerned with the toxicological aspects of chemical products released into the environment.

International Center for Industry and Environment

With single comapnies as well as national and international industrial associations as members, the International Center for Industry and Environment serves as a channel for world industry to contribute to international activities aimed at protecting and improving the human environment. Close contacts of a consultative nature exist with the U.N. Environment Secretariat. ICIE informs members of national and international environmental initiatives of concern to industry.

The European Chemical Industry Ecology and Toxicology Center (EC-ETOC)

ECETOC's main aim is to present a coordinated industry view on the scientific aspects of the ecotoxicity of chemicals. It has 38 members that help to collect all types of ecological and toxicological information on chemicals, and organize testing programs and epidemiological studies on the effects of chemicals in order to protect the human and non-human environment.

The Oil Companies International Study Group for Conservation of Clean Air and Water in Europe (CONCAWE)

This group was established in 1963 by a group of oil refining companies. Today, over two dozen participants represent about 80% of the total refining capacity in Western Europe. The objectives of CONCAWE are to collect and disseminate scientific, technical and legal information dealing with causes and effects of air, water, coastal sea and oil pollution attributable to the oil industry and to the use of petroleum products. Furthermore, CONCAWE aims to promote cooperation among participants on environmental issues and to design and fund research projects to help increase knowledge about pollution caused by the oil industry.